THE

ELECTRICAL REVIEW.

VOL. XXXVII. AUGUST 23, 1895. No. 926.

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BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

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THE TELEPHONE COMMITTEE.

THE evidence submitted to the Telephone Committee has been published in full as a Parliamentary Blue-Book, and is preceded by the Report of the Committee, which simply recommends that the evidence should be reported to the House, and a new Committee appointed in the present session. The swing of the political pendulum has ordained that some of the most active members of the Committee, including those at whose instance it was appointed, and the Chairman who so ably presided over its deliberations, are not at present available for service on a re-appointed Committee. The new member who has to become familiar with the 293 pages of evidence, and to master the important statistics, which comprise a further 35 pages of appendix, is not to be envied. Yet the conscientious perusal of the verbatim report of questions and answers cannot but produce the impression that the original Committee might well have saved any unknown followers the trouble of expressing an opinion for them.

When discussing on June 3rd, 1892, the limited private competition then proposed, we remarked that we very much doubted whether there was any way of settling the telephone question satisfactorily besides absolute free trade or Government purchase. The Committee may be said to have been appointed with a view to demonstrate the practicability of another alternative—municipal competition. The proposers of the Committee realised the futility of commercial competition, and fell back upon municipal competition as the one thing required to place our telephone service upon a satisfactory footing. Realising the value of telephone exchange service, they desired that its use should become more general, and that it should be made available for the service of the small shopkeeper and the working man. Recognising that this aim could only be obtained by reduction in the rates, it was their object to show that the present rates were unnecessarily high, that they could only be reduced by competition, and that competition by municipalities would be feasible, and would be likely to be successful. The evidence brought forward in support of these views was very weak in itself, and did not stand independent examination. Some years ago we drew attention to the peculiar nature of a telephone service, and alluded to conditions therein which prevented the usual virtues of competition having the opportunity of making themselves felt, and it is certainly surprising to us to read some of the evidence brought before the Committee, and to notice that not only municipal politicians, but also the representatives of electrical institutions are unable to realise the difference between telephone exchange service and the supply of electric light. Electric light supplies differ in no essential respect from the supply of gas and water. All these are simply distributive services, the user being only a

recipient of the commodity furnished from a central source. With the telephone the conditions are entirely different; a subscriber is not only a recipient of service, but is also an originator of service; the communication is not merely distributive, but selective, and the service in one area is not independent of others, as is an electric light supply, but needs communication with innumerable branches in distant places. Notwithstanding the different conditions, the advocates of municipal competition point to the success of municipal electric lighting as an argument in favour of municipal telephones; but even on the basis of their own argument the comparison fails, because electric lighting is undertaken by municipalities as a monopoly, whereas they proposed to undertake telephony in competition.

A recognition of the fact which was amply demonstrated before the Committee that a solution of the problem is not to be found in competition, ought to lead to attention being given to the final alternative of Government undertaking the entire service. The monopoly, which is already primarily a Governmental one, should be carried on direct by the Post Office. The present licensees have a limited tenure, and the possible effect of this upon the service may be gathered from Mr. Forbes's reply to question 4,946, showing that expenditure needs to be carefully considered, so that it may be remunerative within the period of the license. As to the terms of purchase, we are not unmindful of the fear sometimes expressed that the Government may repeat, in the case of the telephones, the mistake alleged to have been made on the purchase of the telegraphs, and pay too much for the property acquired; but this argument does not take into account the altered conditions. When the Government acquired the telegraphs, the Post Office had no electrical branch, whilst it has now a department with such experience as enables it to deal effectually with any propositions brought before it. The evidence of the postal officials, administrative and technical, appearing before the Committee, suffices to show that there are no features in the situation which escape their notice.

We have no belief in the lavish expenditure of public money, and no sympathy with those who would deny to private pioneers a reward for their enterprise and energy. The views expressed by Mr. Lamb in answer to question 5,261 we believe will be generally endorsed. He thought that the Post Office would be supported by public opinion in paying a reasonable price for the company's plant, and he indicated the position which the Post Office would assume in the event of unreasonable terms being demanded.

CENTRAL STATION ECONOMIES.

In the paper read before the North-Western Electrical Association, Chicago, on July 17th, 1895, by Mr. J. S. Stephens on "Central Station Economies," the subject is treated somewhat comprehensively and fairly.

This important question has of late been attracting the attention it deserves, and we have on several occasions sought to bring before central station officials the absolute necessity of establishing a thoroughly systematic method of records, both engineering and commercial, to enable them to see where the weak spots are, and so take steps to eliminate them.

Mr. Stephens begins by emphasising the importance of selecting the best possible site for a station, with reference to the centres of distribution, proximity to water and fuel, cost of property and possibilities of future combinations of light and power supply, &c., and advocates the early engagement of a reliable, experienced and practical engineer to advise upon the selection of the site to begin with. His ingenuity and experience should not be expended in designing a plant which will give the best results when erected on the spot selected by a body of men whose sole thought seems to be the cost per square foot of land, irrespective of the fact that a much more efficient plant, both mechanically and commercially, could have been obtained had they availed themselves of the services of their consulting engineer sooner, when the numerous advantages and disadvantages of each likely site would have been considered fully by him.

To English engineers it is refreshing to hear, from time to time, of the way our American cousins go to work. Mr. Stephens's description of an American station is highly amusing and instructive. It would appear that the majority of the buildings are fire-traps covering costly machinery, hot and dirty electric light and power stations, that consist of an aggregation of pitch roof, French roof and flat roof shanks, whose number and date of construction can only be guessed at by the different angles on the outside, and the colour of the interior sheathing. The other extreme—although not so common, we are told—is the building of expensive brick chimneys, the greater proportion of a capital upon which the business in view would pay interest being sunk in these permanent investments, to the exclusion of purchase of economical machinery and intelligent service.

Mr. Stephens makes a few remarks which some of the members of our electric lighting committees would do well to read and ponder over, on the purchasing of what is believed, at the time, to be the best and most suitable machinery, by inviting proposals from all sources, and buying at the lowest prices, the system adopted greatly depending on the prices, schemes presented, and opinions preached by the manufacturers of the different classes of machinery; the main question of obtaining the most power and light for the least cost being lost sight of, or not occupying the important position in the selection of a system which it demands.

Our English method of electric lighting committees making a round of inspection of several central stations on different systems, endeavouring to collect as much information and data as they can which generally amounts to as much as the engineer-in-charge cares to give, returning to their native town with their heads stuffed full of figures, volts, watts, ampères, &c., and then taking upon themselves the responsibility of recommending this or that system as being best suited to their wants, is suicidal. The money spent on these rounds of business, mingled with pleasure, would in many cases pay for a report by one of the most eminent specialists in the profession. The committee would thus be relieved of much responsibility and subsequently the chagrin at having been connected with the promotion of a concern which is no credit to them either from a mechanical or commercial point of view. If

economies are to be practised in a central station, let them be started at the very beginning. Before taking any definite steps, call in the impartial consulting engineer, be guided by his experience and advice, get a plant which will be a success all round, a credit to the town or city, and a pleasure to the engineer-in-charge and his men to run, instead of having to make the best of a bad bargain, and be left far behind in the race for economical working.

Having once secured the proper plant, built on the right site, costing a sum compatible with commercial success, let operations be started in a business-like manner by adopting at the outset a thoroughly systematic method of records of service, including boilers, engines, dynamo, and main losses, coal and engine room stores, consumption, and wages expended, with proper tabulated deductions of averages, along with a suitable system of accounts, and success is assured.

In the discussion following the reading of the paper, various questions were asked, and, as usual, different answers given Some members were in favour of beginning with one large engine only when dealing with the lighting of a new town; some were in favour of two or more units to do the same work. The compound non-condensing and condensing engine were compared with the single cylinder. No one seemed willing to make an emphatic statement, and little was done beyond expressing opinions and asking for information. Not a word was said about the high speed direct driving engine, or the triple expansion condensing engine for electric lighting. Is it possible that the two forms of engines which have proved themselves to be the most efficient for this class of work in England are unknown in America?

We have had occasion to profit by the experience of engineers in other countries now and again, and we venture to think that if our friends of the North-Western Electrical Association were to study our methods in England, they would have very little trouble in deciding on one or more units of plant to do all the work well and economically, or whether the dynamos should be driven by single-cylinder engines.

Boiler Feed Treatment.

A PAPER of considerable interest was presented by Mr. W. D. Jameson before the North-Western Electrical Association of Chicago which dealt with the treatment of scale-forming waters, and its main points of novelty are briefly as follows: In the boiler itself, sulphate of lime can only be successfully dealt with by properly blended sugars which under the conditions existing in a boiler convert the sulphate into a mixture of carbonate and saccharate of lime, and where tannin is present into tannates, all which can be washed out. Carbonates of lime and magnesia can readily be converted into a complex mixture of tannates, easily got rid of. Sodium salts are highly soluble, and concentrate until they reach the super-saturated condition, when they deposit and become very dangerous. We might add to this that before arriving at this degree of concentration there is reason to fear they are a cause of loss through the obstacle they seem to present to the cooling of the boiler plates by water containing the salts. Chlorides of lime and magnesia are unstable, and apt to decompose at high temperatures, evolving hydrochloric acid and causing rapid destruction of the boiler. We have reason to believe that Thames water in the tideway has a seriously corrosive action from this very cause. Magnesium sulphate has a similar instability, producing sulphuric acid, as also have the sulphates of iron and copper, and these sulphates it is almost impossible to neutralise, for if soda be used the sodium sulphate remains behind and concentrates, and if lime be used there is formed gypsum, and the last state is almost worse than the first, but sugars and starchy matter will, if suitably blended, produce a mud that can be washed out. A boiler is an electric generator, and sets up galvanic action between the plates and copper alloy fittings that can be counteracted by the use of some metal, such as zinc, more electro-positive than the iron or steel plates. The greatest galvanic action occurs with pure water or with water holding an excess of salts of soda. Of all forms of corrosion this by electrolysis is the easiest to deal with by vegetable starch and saccharine matter, which will with some extracts of tannin cause corroded pits to heal over. In fact, if Mr. Jameson be right, all the scale-forming ingredients as well as the soda salts can be converted into non-crystallisable oozy mud by the use of suitably-blended sugars, starches, and tannin, the latter being also effectual in dealing with the oil that enters a boiler, though it is not said if this includes mineral oils which alone now are likely to get inside a boiler. The sum of the paper is that a mixture of slippery elm, starches, sugars, and tannin, with sometimes 5 to 10 per cent. of soda to cut the starches and aid the action of the sugars, will do all that can be done in preventing scale. As more or less perfect mixtures of such substances are sold as boiler compositions, our advice to those who use them is that they should be fed the day through in company with the feed water and not in large single doses; that they should be used with care to prevent overheating of the plates, which might occur with too heavy a use of substances whose tendency is to render the water "thick and slab;" and that blowing out should be frequent as possible rather than copious. There are so many compounds sold whose value, if any, is purely confined to local waters and anything but general, that great care should be exercised in this matter, for some of them are apt to be more dangerous than the scale they are intended to prevent.

A Little Learning, &c.

WHEN the Livet boiler was prominently before the public, we remember that a Mr. Garwood, M.Inst.C.E., appeared in print as a supporter of its pretensions. If we mistake not, the same gentleman has put his ideas on the question of "Electric Light *v.* Gas-light," in the form of a small pamphlet which has been circulated in Newport (Mon.). In it the writer has continued to propagate the delusion that light for light, hours for hours, the ratio of cost of electricity to gas is as 1d. per unit to 6d. per 1,000 cubic feet. This subject has been so thoroughly thrashed out in these columns that we do not think it worth while to go over all our arguments again. It is sufficient to point out that Mr. Garwood says: "An ordinary 5 feet gas burner may be taken as giving 10 candle-power," whereas as a matter of fact, with a fairly good burner, 4 candle-hours can be obtained for every cubic foot of gas burned. An incandescent lamp, taking 30 watts, is said to give 10 C.P., which is too low for average consumption during life of an ordinary lamp, but later on we meet with this wonderful and conflicting statement, "16 C.P. lamp absorbs 60 watts per hour (a unit is 1,000 watts)". To appreciate fully, however, the value of the information given, we only need to quote two examples of definitions, and will leave the rest to the intelligence of our readers. "The ampère is the unit of current. The amount of current in any conductor at any instant is expressed in ampères." "The resistance of insulators is expressed in meghoms. A meghom is 1,000,000 ohms."

THE MONOCYCLIC SYSTEM.*

Having received many requests for an explanation of the monocyclic system in brief and simple language, Mr. C. P. Steinmetz, at our request, has prepared the following note which, we believe, will make its features thoroughly plain to all of our readers.

The monocyclic system was designed to replace the old type single-phase system of alternating current distribution by offering among other features the advantage of being able to supply power to alternating current motors which are self-starting under full load.

The monocyclic generators differ from the old single-phasers only by having midway between the main slots a second set of small and shallow slots, as shown in fig. 1,

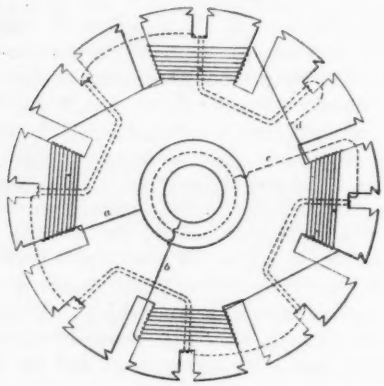


Fig. 1.

which contain a supplementary or teaser winding, shown in dotted lines.

The conductors of the teaser coils are of the same cross-section as those of the main coils, but the former contain only one-quarter the number of turns of the main coils,

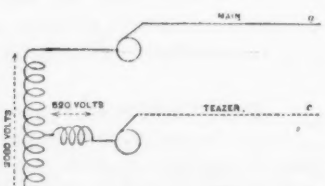


Fig. 2.

and thus give only one-quarter the E.M.F. The teaser winding is connected with one end to the third or middle collector ring, and the other end to the middle of the main winding, as shown diagrammatically in fig. 2.

In this way, the teaser current has to return over the main coil, and thus meets beside the self-induction of the teaser, also the self-induction of the main winding. This feature, in combination with the higher impedance of the teaser line, as compared with its voltage, is made use of to limit the flow of current in the teaser circuit, by dropping the voltage of that circuit as soon as current is taken off, and thereby maintaining the flow of power fluctuating in the same way as it is in the old single-phase system.

The teaser voltage of the generator cannot be measured directly, since only one terminal for the teaser winding is accessible. The potential difference between the main or outside collector rings is that of the main coil. The difference of potential between the middle or teaser collector ring and any one of the main collector rings is the resultant of the teaser voltage and half the main voltage.

* *Electrical World*, New York.

Since the teaser voltage at open circuit is ·25 of the main voltage, the voltage between teaser and main collector ring is $e = \sqrt{\cdot 252 + \cdot 52} = \cdot 57$ of the main voltage.

For the operation of standard induction motors, the primary voltage is transformed either by two transformers of equal size, as shown diagrammatically in fig. 4, or by a large or main, and a small or teaser, transformer, as shown in fig. 6.

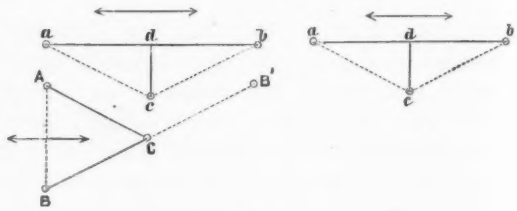


Fig. 3.

The diagram of E.M.Fs. corresponding to fig. 4 is shown in fig. 3, a, b being the primary main, and c, d the primary teaser, voltage. Thus the dotted lines, a, c and c, b, are the resultant voltages between main and teaser wires, differing from each other by somewhat less than 60°. By transformation, a, c changes to A, C, and c, b to C B'. Since, however, this secondary coil is reversed, the secondary voltage becomes C, B, and thus gives the secondary triangle A, B, C, of which the side A, B is the product of twice the teaser voltage by the ratio of transformation, while the sides A, C and B, C are resultant voltages of main and teaser. The energy current supplied to the motor over the wire C, divides and returns partly over A, partly over B.

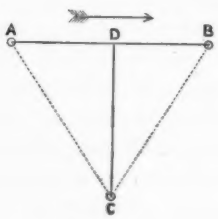
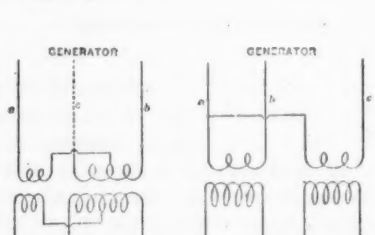


Fig. 5.



Figs. 4 and 6.

By transformation by means of main and teaser transformer, shown as E.M.F. diagram, fig. 5, the teaser voltage c, d is transformed at a different ratio from the main voltage a, b, and thus changes the altitude c, d of the primary triangle a, b, c to that of the secondary triangle A, C, B, which is such as to give nearly an equilateral triangle. However, though the secondary E.M.Fs. give approximately an equilateral triangle, the flow of current, due to the inability of the teaser to supply large currents, remains practically in phase with the main E.M.F.; that is, neglecting the angle of lag of the motor, it would be in the direction marked by arrows in figs. 3 and 5.

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 148.)

The Different Forms of Lamps.

The incandescence lamp is constructed, as we have described in the course of these articles, at most lamp works, with the exception of certain little points of detail that do not affect the main principles of its fabrication. Thus, the incandescence lamp always consists, roughly speaking, of a carbon filament enclosed in a sealed glass bulb, and this filament is put into communication with the source of electricity by two metal rods passing through the bulb. The desire to avoid infringing the Edison patents which in America completely monopolise the lamp industry, has given rise to new forms. Such is the Westinghouse lamp, which was described to us last year.

In this lamp, it appears, the bulb would not be sealed by melting the glass, but would be closed by a plug bearing the filament, a plug formed of a special kind of cement, the composition of which was not given. Without wishing to assert that it would be impossible, it seems to us that it would at any rate be very difficult to maintain the almost perfect vacuum necessary to the existence of the lamps by means of any composition; in fact, it must adhere very closely to the glass and to the metal in order not to leave any crack, however small; it must be perfectly air-tight itself; and, moreover, it must be capable of resisting the heat given out by the lamp when lighted, and it must have the same properties when hot as when cold. We all know the difficulty attending the sealing of the metal rods that support the filament, and the precautions that must be taken in order to obtain the perfect adherence of the glass which is softened, and almost melted, on the surface of these wires. We know what conditions the metal must satisfy in order to realise a perfect joint; and, again, we can only obtain satisfactory sealing with wires of rather small diameter. When the sealing is not performed with sufficient care, it leaves, between the glass and the surface of the metal, little cracks, or infinitely small channels, which are amply sufficient to allow of the entrance of air, which is quickly fatal to the lamp. Nevertheless, if the composition used for the plug fulfils all the above conditions, a lamp constructed on this principle might have certain advantages; and, in particular, the question of repairs, such as the renewal of the worn out filament, for instance, would be greatly simplified. This renewal, which has been attempted with the ordinary lamps, not, however, very successfully, would mean a considerable economy in the lamp manufacture.

We should be very glad to be able to examine this lamp, which certainly shows great originality, and solves a very delicate problem.

Other forms of lamps have also been proposed, not in order to fight the Edison patents, but in order to create new forms. Such are the lamps with more than one filament which have been patented over and over again. Indeed, these lamps have been produced by all makers in order to satisfy special requirements, and they present no special feature, unless it is a fresh complication in the already too complex manufacture of the incandescence lamp.

The advantages claimed by the patents are the possibility of increasing the duration of the lamps in proportion to the number of filaments collected in the same bulb, and also the possible increase of the luminous power by the simultaneous lighting of two or more of these filaments suitably grouped.

In our opinion these lamps present no special interest, especially since the fall in price of the ordinary lamps; on the contrary, their manufacture, as we have already said, is certainly more difficult as regards skill, and more costly as regards material. Moreover, they require special sockets, placing a new filament on circuit automatically as soon as the one in use is broken; their price must therefore be higher. The only saving that can be realised by the employment of these lamps, as against the ordinary lamps, consists in the diminution of the rate of the sinking fund; even supposing that the price is the same as that of the ordinary lamp, we shall see the economy realised would be very small.

Let us take a 16-candle lamp, for instance, the duration of which is 500 hours, and the price 1·50 franc. The sinking fund per hour of lighting would be $\frac{3}{10}$ of a centime for a consumption of current of 6 centimes (50 watt-hours at 12 centimes the hecto-watt-hour); the sinking fund of the lamp represents, therefore, 5 per cent. of the cost of the consumption of current, or 4·8 per cent. of the total cost. Assuming that the two-filament lamp has a double duration, the sinking fund of the price of the lamp will not represent more than 2 per cent. of the total cost, *i.e.*, the economy realised will be 2·8 per cent. It must be understood that this calculation supposes that the bulb of the lamp is not blackened when the second filament is put in service, which cannot be realised. Therefore, then, supposing even that the lamp with the double filament is not dearer than the ordinary lamp, and that the second filament is placed when it enters in service under conditions similar to those realised by a new lamp, the economy resulting from the employment of such a lamp would not amount to 3 per cent., if we take as a basis that the price of the lamp is 1·50 franc. It is evident that these various hypotheses cannot be realised practically. The lamp with more than one filament will always be dearer to make than the ordinary lamp, and consequently its selling price can never fall so low. Not only must the second filament inevitably enter into service under different conditions to those attending the single filament of an ordinary new lamp, but the first one lighted will have become more or less deteriorated before lighting, either by the two filaments rubbing together, or by the hooks intended to prevent them from touching. As soon as one filament is lighted, the other, be it understood, is subjected to all the influences that affect the atmosphere of the lamp, and also to the calorific radiation from the incandescent filament, there will therefore be produced on the cold filament a deposit of carbon similar to that which covers the inner surface of the bulb, in which case the surface and the electrical constants are modified; its working will therefore no longer be normal.

If we have dwelt at some length on these lamps with more than one filament, it is because recently there have been various attempts to bring them forward. Now we think honestly that this form of lamp is far from interesting, and will become less and less so, and that its use in fact should be limited to quite special cases. Thus it may be advantageous to have recourse to more than one filament in constructing certain lamps of high voltage and great luminous power; but in that case these filaments are lighted all together, as a rule at least.

Lamps with a luminous power of more than 50 candles, which are not much used as yet, but which have, in our opinion, a great future before them, also constitute special types, differing in many points of their manufacture from the ordinary lamp. The filament is often made differently, its mounting on its support requires special manipulations; the sealing of the support into the bulb presents serious difficulties, especially when lamps of very great luminous intensity are used; in short, these lamps, although similar in their essential principles to the ordinary lamp, require special skill and special experience in their manufacture in order to avoid unsuccessful results. These peculiarities of construction, which are very little known even to the makers of ordinary incandescence lamps, and which require a great deal of testing, probably constitute one of the reasons for the very limited use of this type of lamp up to the present.

We believe, we say, in the future of large incandescent lights. There are, in fact, several reasons why such lamps, when well constructed, should come into favour. The inconveniences caused by the employment of arc lamps constitute one of the principal reasons for this future. It is generally objected that the candle-hour costs more with lighting of this kind than if the light is produced with the arc; however, a somewhat exhaustive discussion of the question, which we had occasion to publish last year (see *L'Electricien*, No. 137, p. 97), seems to say that this extra expense is only apparent, and that really incandescence may, in certain cases, enable a certain fixed quantity of light to be produced cheaper. Moreover, we may, I think, assert that, generally speaking, this advantage is maintained, if we take into consideration the want of reliability and other inconveniences resulting from the employment of the arc,

* *L'Electricien.*

considerations which cannot be reduced to figures, and which, consequently, do not appear in our calculations. The incandescence lamps of great luminous power have, in fact, advantages over the ordinary types as regards consumption; thus we can realise in lamps of this kind types in which the consumption is greatly reduced; at 2 watts per candle, these lamps are still available for industrial purposes. This difference seems to depend specially on the great calorific elasticity presented by filaments of large section, which enables them to bear oscillations of current that would soon be fatal to the filaments of small diameter required for this rate of consumption when lamps of ordinary types are used.

The peculiar elasticity of working of the incandescence lamp has enabled this mode of lighting to be applied to various scientific apparatus. These applications have necessitated the creation of new types which do not differ essentially from the ordinary lamp; but some of them have some interesting features.

Small lamps with a diameter of only a few millimetres are used in medicine and surgery. The lighting of lenses, projecting apparatus and astronomical telescopes, requires lamps in which the filament is compressed into a very small space, and perhaps practically reduced to a point. This has led to the manufacture of filaments coiled up like the spiral springs of a watch, which give complete satisfaction, and have enabled the efficiency of the apparatus to be considerably increased. Lamps of great luminous power, but occupying very little space, have also been successfully produced, for replacing the oil lamps in lighthouses, the same optical apparatus being used. This application may be of great interest, as it enables the power of these lights to be considerably increased, at little cost, by virtue of the great homogeneity of the light thus obtained.

The use of triphased currents has also given rise to a new type of incandescence lamp with three poles. Lastly, lamp makers have also been asked for types adapted to purposes of adornment and decoration; this has given rise to those microscopic lamps, lighted by portable batteries, and to the various kinds of fancy lamps in the form of a candle, flame, &c., which do not, properly speaking, constitute special types, but which, nevertheless, present greater difficulties of construction than ordinary lamps.

(*To be continued.*)

THE ECONOMY OF CONSTANT POTENTIAL ARC LIGHTING.

Writing to the New York *Electrical Engineer*, Mr. W. N. Stewart, of Minneapolis, says:—"Members of the electrical profession are not usually to be accused of running too much in a groove, or of not being open to the reception of new ideas. But the statement that constant current arc lighting is much cheaper than constant potential arc lighting is so often made, that it has come to be received as electrical gospel. This statement is again repeated in the *Electrical Engineer* of July 17th by Mr. E. R. Knowles. It seems to be assumed that the loss in resistance on a constant potential circuit is the only factor in the calculation, without considering others which may enter into the sum total of cost. Will Mr. Knowles oblige a seeker after light by considering the following propositions affecting arc lighting, and then put a little of his well-known mathematical skill into working out a correct solution?

"Admitting that his proposition is correct, viz., that two 7-ampère arc lamps require 330 watts on a constant current circuit, and 385 watts on a constant potential circuit, let him consider the following questions: Has or has it not been determined that a large multipolar generator of the constant potential type is a much more efficient generator than the customary (or any) type of constant current machine? Silvanus P. Thompson, in his well-known book on 'Dynamo Electric Machinery,' gives the efficiency of a standard type of constant current machine at 86 per cent. when new. What is it when old? The better class of constant potential machines give an efficiency of 95 per cent., or higher, and retain it. How much does the superior efficiency of the generator help the constant potential lamp?

"In a plant of 1,000 arc lights, it would be necessary to run 10 constant current machines of 100 lights each, if the best modern machines are used. With a constant potential system, one machine would easily do the work. Query, what would be the difference in cost of driving the 10 machines over the one, either by belting and countershafting from one large engine, or by 10 engines direct connected to dynamos? Calculate difference in friction, oil, labour, interest on cost of real estate and building, wear and tear of belting (if any used), and increased depreciation on high speed machines in place of slow speed.

"Constant current armatures have been known to burn out. What is a fair allowance per annum for this item, over wear of a good constant potential armature?

"If 100-light machines are used on the constant current system, a potential of 5,000 volts, or over, must be used. What is the danger factor on this class of wiring, and what is the extra risk worth per annum to the company using it?

"How much will it cost yearly to maintain good insulation on lines carrying 5,000 volts over the cost of the same work on circuits carrying 220?

"Out here in the wild and woolly West some of our college professors are teaching us that as much light can be had from a cored carbon at 8 ampères as is usually obtained from the common carbons with 9½, and at about the same cost per hour for carbons. We are building stations, using constant potential arc lighting for streets and stores, and operate our incandescent circuits from the same direct connected dynamo. We think that results show lower operating expenses and better lighting from these systems than from the old style stations containing several types of dynamos. If we are so very wrong in our conclusions, and Mr. Knowles will show us just where we are wrong, we will repent in sackcloth and ashes and go back to the good old way. We will admit that we use more wire by doing things in this manner, but by running four lamps in series on 220 volts with iron line wire in place of the usual resistance coil, it is surprising how little wire can be made to go a long way, with properly proportioned feeders.

"We think that good carbons mean less cost for current, that one big speed generator is better than a number of small ones, and that the resistance loss is more than saved in the absence of belting and shafting, in the superior economy and efficiency of the generator, in saving of employés and absence of danger, while the first cost, after paying for more copper, is no more, because we save in machinery, building, real estate, and many other items. If we are so woefully wrong, won't some one please show us just how much we are wrong?"

ALTERNATE CURRENT MOTORS.

By W. G. RHODES, M.Sc.,
City and Guilds of London Institute. Central Technical College.

(*Continued from page* 183.)

Before leaving the consideration of armature reaction it will be instructive to see in what cases the effect may be got rid of in ordinary alternate current machines.

If we have an alternator running as a generator with no other source of electromotive force in the circuit there will always be armature reaction, since the self-induction of the circuit will cause the current to lag behind the E.M.F. of the machine; moreover, this armature reaction will tend to *weaken* the field. The output of the alternator will therefore be diminished for two reasons, viz., the self-induction of the circuit causes the current to lag, thereby creating a wattless component, and also the field in which the armature rotates is weakened by the armature current. We can, however, by putting in the circuit a condenser of suitable capacity, nullify the effect of self-induction and cause the current to be in phase with the E.M.F. of the machine. The proper value of the capacity to take for this purpose is given by

$$2\pi n \mathrm{K} = \frac{1}{2\pi n \mathrm{L}},$$

where n is the frequency of the current, L the self induc-

tion of the circuit, and K the capacity required. If the capacity inserted satisfies the above equation there will be no wattless component of the current and the field will be unaffected by armature reaction.

In the case of a plant consisting of generator and motor we have seen that by exciting the field of the motor to a proper extent the current can be brought into phase with the E.M.F. of the generator, and that when this is the case the generator field will be unaffected by armature reaction, while that of the motor is strengthened.

The foregoing investigation must only be regarded as a first approximation to the truth because whenever there is a change in the field strength due to armature currents the fluctuations of the induction will induce currents in the field coils, and, unless the field-magnets be well laminated, eddy currents in the iron, which will diminish the effect of the armature reaction as calculated above. We cannot here obtain a numerical estimate of the effect of these induced currents but will content ourselves with saying that in all practical cases their nullifying effect on the armature reaction is but small.

Stability of a Plant consisting of Generator and Motor.

The plant is said to be working in a condition of stability if, for a small increase or diminution of the output of the motor, or for a small increase or diminution of the E.M.Fs. of generator or motor, it will continue to work.

We shall suppose the E.M.F. of the generator on open circuit to remain constant, so that the question of stability will involve two distinct problems, viz.: (1) Given the E.M.Fs. of generator and motor and the resistance, &c., of the complete circuit consisting of the two armatures and the line, when will a breakdown occur if the load on the motor (*i.e.*, its output) is varied? and (2), given the E.M.F. of the generator, the output of the motor, and the resistance, &c., of the complete circuit, between what limits may the counter E.M.F. of the motor be varied without a breakdown occurring?

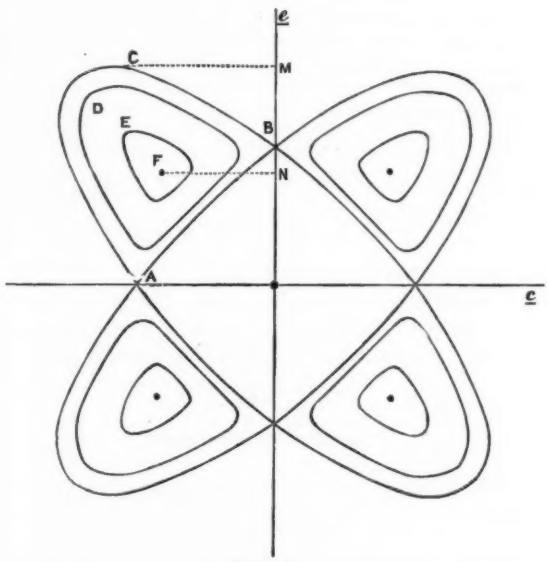


FIG. 12.

If we refer to the second article of this series we see that the maximum value of the output (p) is given by

$$p = \frac{E^2}{4\,R},$$

where E is the E.M.F. of the generator and R the resistance of the circuit. If we do not know the E.M.F. of the generator, but only the *impressed potential difference* at the terminals of the motor, the same expression still holds good for the maximum output, E now representing the difference of potential at the motor terminals, and R the resistance of its armature. The above expression gives the maximum power that *can* be transmitted over the given resistance for a given value of the E.M.F. of the generator.

The fundamental equation has been obtained in the form

$$E^2 - e^2 - I^2 i^2 - 2\,R\,p = 2\,S\,\sqrt{i^2 e^2 - p^2}.$$

If E, R, S, and p are given, this equation gives a relation between the current, i, and the counter E.M.F. e of the motor. We can, therefore, plot a curve with values of e for abscissæ, and corresponding values of i for ordinates; and by giving different values to p, a series of such curves will be obtained. We may call them *characteristic curves*. A series of characteristic curves is given in fig. 12.

The fundamental equation is of the fourth degree in i and e, and is symmetrical with respect to the axes (since e and i occur only with even exponents).

The curves in the first and third quadrants represent the condition of affairs when the machine is running as a generator, since in those quadrants, e and i have always the same sign. In the second and fourth quadrants the machine is running as a motor. The symmetry of the curves renders a detailed consideration of the second quadrant sufficient.

In fig. 12, then, A B C, is the characteristic curve corresponding to zero power, and the point, F, corresponds to maximum output. We see from the curves that when the output of the motor is zero, the E.M.F., e, may have any value between the limits O and O M $\left[= \frac{I\,E}{R}\right.$: see second article$\left.\right]$.

On increasing the output till its value corresponds to the curve, D, the interval between the limiting values is diminished; this interval will continue to diminish till the point, F, corresponding to maximum output is reached. The value of e here is $\frac{I\,E}{2\,R}$ (see second article); that is, the maximum value of e at zero power is double its value at maximum output; or O M = 2 . O N.

We proceed to find the interval between the limiting values of e for any given output. Squaring both sides of the fundamental equation, we can put in the form

$$I^4 i^4 - 2\,(I^2 E^2 - I^2 e^2 - 2\,R\,I^2 p + 2\,S^2 e^2)\,i^2 + (E^2 - e^2 - 2\,R\,p)^2 + 4\,S^2 p^2 = 0.$$

Solving this as a quadratic equation in i^2, we get

$$i^2 = \frac{I^2 E^2 - I^2 e^2 - 2\,R\,I^2 p + 2\,S^2 e^2}{I^4} \pm \frac{1}{I^4}\sqrt{\{(I^2 E^2 - I^2 e^2 - 2\,R\,I^2 p + 2\,S^2 e^2)^2 - I^4\left[(E^2 - e^2 - 2\,R\,p)^2 + 4\,S^2 p^2\right]\}}.$$

Now i must be real, therefore i^2 must be real and positive. This gives us as a first condition that the quantity under the square root must be positive, or, in the limit, zero; that is

$$(I^2 E^2 - I^2 e_2 - 2\,R\,I^2 p + 2\,S^2 e^2)^2 \geq I^4\,[(E^2 - e^2 - 2\,R\,p)^2 + 4\,S^2 p^2.]$$

Remembering that $I^2 = R^2 + S^2$, this reduces to

$$I^2 e^2 E^2 \geq R^2 e^4 + 2\,I^2\,R\,p\,e^2 + I^4 p^2.$$

or, taking the square root of both sides

$$I\,e\,E \geq R\,e^2 + I^2 p. \qquad (10)$$

The limiting values of e, for any given output, p, are therefore given by the equation

$$R\,e^2 - I\,E\,e + I^2 p = 0, \qquad (11)$$

provided, at the same time, the condition

$$I^2 E^2 - I^2 e^2 - 2\,R\,I^2 p + 2\,S^2 e^2 \geq 0 \qquad (12)$$

is satisfied, since this is necessary in order that i^2 may be positive.

It is not difficult to show that (12) is satisfied by all values of p and e which satisfy (10), for by (10) we have

$$I^2 p \leq I\,e\,E - R\,e^2,$$

therefore

$$\begin{aligned} I^2 E^2 - I^2 e^2 - 2\,R\,I^2 p + 2\,S^2 e^2 &> I^2 E^2 - I^2 e^2 - 2\,R\,(I\,e\,E - R\,e^2) + 2\,S^2 e^2 \\ &> I^2 E^2 - 2\,R\,I\,e\,E + R^2 e^2 + S^2 e^2 \\ &> (I\,E - R\,e)^2 + S^2 e^2 \\ &> \text{an essentially positive quantity.} \end{aligned}$$

Thus, when (10) is satisfied, so also is (12). It will, therefore, be sufficient to see that condition (10) is always satisfied.

Provided, then, that

$$R\,e^2 - I\,E\,e + I^2 p \leq 0,$$

the current will be real, and we shall have a possible working condition of the plant.

Solving equation (11) we get

$$e = \frac{I E}{2 R} \pm \frac{\sqrt{I^2 E^2 - 4 I^2 R p}}{2 R}$$

$$= \frac{I E}{2 R} \pm \frac{I}{2 R} \sqrt{E^2 - 4 R p}. \qquad (13)$$

This gives the maximum and minimum values of e when E and p are given. If we consider p as variable it also gives the greatest possible value of e for a given value of the generator E.M.F., this occurs when $p = 0$, and the greatest possible value of e is given by

$$e = \frac{I E}{R}$$

$$= E \sec \theta.$$

where $$\theta = \tan^{-1} \frac{S}{R}.$$

In our second article we observed that the counter E.M.F. of the motor might be greater than the E.M.F. of the generator. We are now in a position to make a more definite statement and say that, neglecting losses due to friction and hysteresis, a generator of E.M.F., E, can drive as a motor any alternate current machine whose counter E.M.F. lies between the values 0 and E sec θ, where θ is defined by the equation

$$\tan \theta = \frac{S}{R},$$

S being the total reactance, and R the total resistance of the two armatures and the line.

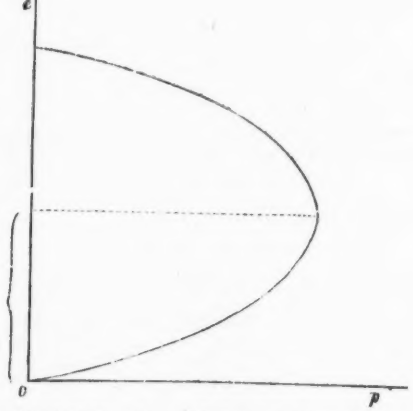
It will be well to remember, however, that for the above statement to be true, e and E are not the E.M.Fs. on open circuit, but the E.M.Fs. due to rotation in the resultant fields determined by the exciting currents, together with the armature currents.

Referring again to equation (11), we may determine the interval between the limiting values of e for a given value of p from the solution given in (13), or we may do so by graphical methods.

Equation (11), considered as a relation between e and p is a parabola with its vertex at the point

$$\left.\begin{aligned} p &= \frac{E^2}{4 R} \\ e &= \frac{I E}{2 R} \end{aligned}\right\}$$

and is represented in fig. 13.



The dotted line shows excitation of maximum stability.

FIG. 13.

For any value, p, of the output there are two limiting values of e, and the interval between these values is represented by a chord of the parabola perpendicular to its axis.

First, let us consider the stability for variations of e. Let e_1 and e_2 be solutions of equation (11) so that

$$e_1 - e_2 = \frac{I}{R} \sqrt{E^2 - 4 R p}.$$

A glance at fig. 13 shows that the value of e which gives the greatest stability for positive or negative variations of e is given by

$$e = \frac{e_1 - e_2}{2} + e_2$$

$$= \frac{e_1 + e_2}{2}$$

$$= \frac{I E}{2 R}.$$

That is, in order that the stability may be a maximum at any load whatever for positive or negative variations of the counter E.M.F. of the motor, the counter E.M.F. should have the value corresponding to maximum output.

The same value of the counter E.M.F. obviously gives the maximum stability for variations of the load. It may not, however, be always convenient or necessary to excite the field of the motor to such an extent. Under these circumstances the proper method of procedure is as follows:—Excite the field of the motor till the counter E.M.F. has the *minimum value* corresponding to the *greatest load* to which the motor is likely to be subjected. The value of the counter E.M.F. can be calculated either from the formula (see (13)).

$$e = \frac{I E}{2 R} - \frac{I}{2 R} \sqrt{E^2 - 4 R p},$$

or from a previously drawn curve such as is given in fig. 13.

We again note that for the motor to run at all its counter E.M.F. must lie between the limits 0 and $\frac{I E}{R}$: also the stability at no load is a maximum, and at maximum load is zero.

As an illustration of the practical utility of the stability problem we give an example.

Take the case given in our second article of a 100 kilowatt motor driven by a 3,000 volt generator, the resistance of the circuit being 15 ohms and the reactance 30.

Suppose we know that the normal load is 100 kilowatts, and that the greatest variation of load is 20 per cent. of its normal load; that is the load will never exceed 120 kilowatts.

We then have

$$I = \sqrt{15^2 + 30^2}$$

$$= 33{\cdot}54$$

and the proper value of the counter E.M.F. is given by

$$e = \frac{33{\cdot}54 \times 3{,}000}{2 \times 15} - \frac{33{\cdot}54}{2 \times 15} \sqrt{3{,}000^2 - 4 \times 15 \times 120 \times 10^3}$$

$$= 3{,}354 - 1{,}499 \text{ approximately}$$

$$= 1{,}855 \text{ volts.}$$

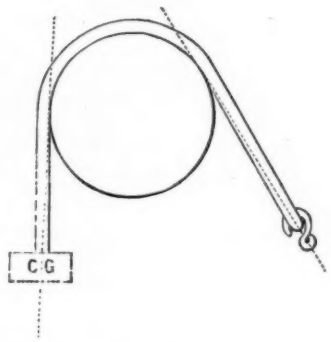
This gives the extent to which the field of the motor must be excited in order to avoid the risk of a breakdown.

(To be continued.)

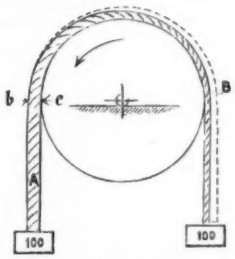
THE RADIUS OF A BRAKE STRAP.

SOME little time since we ventured to speak approvingly of the French system of measuring the radius of a brake pulley at the centre of the brake strap itself. We had no intention of posing as originators of such a mode of measurement. But a correspondent says that the true radius is the radius of the drum itself, for, he says, with a flexible band the C.G. of the weight will hang below the rim surface. As we were talking of actual brake straps and not of impossible flexible bands such as supposed by our correspondent, we pointed this out and used as an illustration the idea of a tapering rope as per sketch herewith, and suggested that by such a device, of two equal weights, that on the thick end of the rope would overbalance the other even with the extra weight of the thick end of rope suitably balanced. A contemporary, whose reasoning powers run in a circle, at once snaps up this illustration as a proof that we advocate perpetual motion devices, being apparently too

ignorant and blind to perceive that the instantaneous lever arm of the weight at the thick end of the rope is greater than that at the thin end, and therefore there can be no question of *perpetuum mobile*. We would not have further

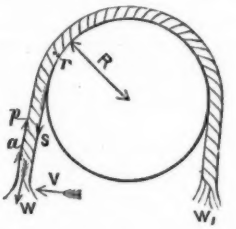


referred to the matter were it not that an erroneous assumption should be combatted. When a band is bent round in a circle its outer periphery is stretched and the side next the



pulley is compressed. At such a point as a, a pull W, if small, will be resisted by an upward pull in the rope of p, and helped by a downward push s, the effect of the couple being to push the weight, W, in the direction of the arrow, V. Increase W, and there will still remain a difference between p and s, and there will always be the tendency V, which in practice causes the weight, W, to hang near the centre line of the rope, or at a radius $R + r$. The pull of the back weight, W_1, of a brake strap, also acts at the same radius, but as this pull is of necessity less than that of W, the net resistance of the brake is simply

$$2 \pi N \{(R + r)(W - W_1)\}.$$



It is a pity that our contemporary's thirst for our blood should be such as to lead it to search for a *perpetuum mobile* in so obvious a mechanical fact. Evidently our contemporary has got to learn that equal weights do not balance one another when acting at unequal distances or through unequal spaces. But it is really going too far when our contemporary hints that it might let out some cold scientific criticism. Our contemporary is not built that way. It set out a few years ago on designedly flippant lines, and has in this at least been consistent.

SELF-MOTIVE CARRIAGES AND ELECTRIC ACCUMULATORS.

The foolish race, writes M. Hospitalier in *L'Industrie Electrique*, that has just taken place between Paris and Bordeaux and back, has brought out incontestably the advantages, henceforward indisputable, of petroleum, or more correctly, of the essence of petroleum or gasoline; it has relegated steam to the second rank, and placed electricity much lower still on the list, for a partisan of this mode of locomotion, as bold as rash, presented a carriage which would traverse the 1,775 kilometres of the course, if not in the 100 hours allowed to competitors, at any rate in a time more suited to the future applications reserved for self-motive carriages on public roads.

We need not wonder at the almost entire absence of electricians from this competition, the object of which still remains a mystery to many, and to some a bitter deception.

As regards the bicyclette, the interest attached to the races is, and only should be, ephemeral: practical applications only will survive, and the competitions that present the most practical character are those that will render the greatest service to the development of self-motive locomotion, the dawn of which is appearing at the end of this century. From this point of view, the competition of carriages without horses, instituted last year by the *Petit Journal*, was much more useful, and responded far better to a real want than the Paris-Bordeaux-Paris race.

But long races from town to town, and long trials of speed over long distances, are not suited to electric carriages deriving their electrical energy from accumulators; these carriages must really be placed on the same footing with carriages drawn by horses which start in the morning and return to the coach house at night, so as to recuperate during the night the energy expended during the day. And, again, these carriages are only suited to applications for conveying people either for purposes of business or pleasure; in a word, we want to realise the electric cab or carriage. For conveying goods, the place is already filled and well filled by the gasoline carriages, which are already used by a number of firms for their town deliveries.

A few general figures will suffice to show the superiority of gasoline from a mechanical and economical point of view.

The motors of 2 to 5 H.P. used on the gasoline carriages consume about 500 gr. of a density of 0·7 per mechanical H.P. hour available on the axle of the motor.

Taking transmissions into account, when considering the efficiency, 1 kg. of gasoline represents at least 250,000 kgm. available at the rim of the wheels. With the boilers used on the steam carriages, 1 kg. of good coal produces at most 6 kg. of steam, and the non-condensing motors consume at least 18 kg. of steam per H.P. hour, or 5 kg. of coal per H.P. hour. One kg. of coal, therefore, produces at the most 90,000 kgm. on the motive axle, and 50,000 kgm. available for traction at the rim of the wheels, taking transmissions into account.

An electric accumulator produces now a maximum of 15 ampère-hours at 2 volts, or 30 watt-hours, or 18,000 electric kgm., which represents 5,000 kgm. available at the rim of the wheels, taking into account the efficiency of the motor and transmissions. We may assume that the weight of gasoline, steam, and electric motors are to all intents the same, but the petroleum motor necessitates the transport of a certain quantity of water for cooling purposes, and the steam engine that of a still larger quantity of water to be converted into steam on the journey, whilst with the accumulator we must transport a considerable and constant weight. It follows from this that the figures, 250,000, 50,000, and 5,000, do not represent the respective values of the mechanical energy utilised in the three kinds of self-motive carriages. A closer comparison lowers the comparative value of the steam engine, and raises that of the petroleum engine, since the latter has not to carry uselessly, like the accumulator carriage, a considerable dead weight, the transport of which absorbs the greater part of the available energy.

These figures show that there is no chance of competition between the accumulator carriage and the gasoline carriage in a speed test like the Paris-Bordeaux-Paris race, and they justify the almost entire absence of the former, for only two carriages of the kind were entered, and only one really took part in the competition, arriving at last at Bordeaux after numerous mishaps on the way. But steam has many objections which it would be puerile to mention; petroleum engines have to be started by hand after each little stoppage, they are noisy and productive of much jolting, they exhale

an odour which is far from agreeable, and often they can only be persuaded to ascend hills of any steepness on the condition that the passengers are obliging enough to dismount, and sometimes even push the vehicle.

Whilst rendering all due honour to gasoline, and sincerely applauding its success, and notwithstanding the unfavourable figures that we have just quoted, electrical carriages offer such advantages as regards comfort, convenience, simplicity of manipulation, &c., that we must still persist in believing in their superiority for a metropolitan service in large towns provided with distributions of electrical energy. The electric carriage will best solve the problem of the *electric cab*, the possibility of realising which we suggested in 1881, and which, it seems, is on the eve of being realised in Paris itself.—*Qui vivra verra.*

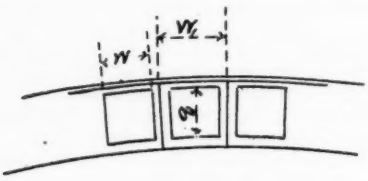
ARMATURES AND MAGNET COILS.

By CLAUDE W. HILL.

The following handy formulæ have been devised by the writer for the purpose of facilitating the calculations relating to dynamo machinery.

Armature Temperature.—It has been found by various experimenters that for ordinary wire wound armatures running at the usual peripheral speed of about 3,000 feet per minute, the rise of temperature is 1° Centigrade for every 0·03 watt per square inch of armature surface.* This is an average figure found by dividing the total watts by the total surface.

Fig. 1.



Figs. 2.

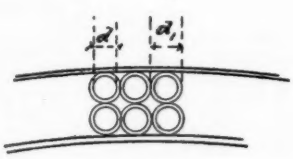


Fig. 3.

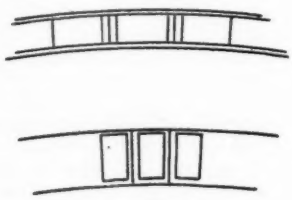


Fig. 4.

The watts per square inch will, of course, be greater in ring armatures at the ends and in the hole, and in drum armatures at the ends, than on the periphery. Copper being a good conductor of heat, any increase of temperature at one part of the armature is speedily conducted to the cooler portions, so that a practically even conductor temperature is maintained over the whole armature.

In designing an armature, it is customary to base the size of conductors upon some arbitrarily chosen current density. The number of conductors which can be packed into the periphery is then found, and the length of armature suitable for the voltage and speed determined. The surface is then measured up, the watts lost in the conductors is calculated, and to them is added an estimate of the watts loss in hysteresis and eddies. The temperature is then reckoned, probably to find that is very different to what is required, and so the whole process of designing has to be repeated.

It would seem a somewhat more expeditious process to calculate the conductors the right size for the temperature to begin with. To do this, it is not necessary to know the whole surface of the armature; it is sufficient if we take a fractional portion, say, that due to one conductor, 1 inch long, see fig. 1. The surface is then $w_1 \times 1$. The resistance of a piece of copper, 1 inch long × 1 sq. inch section being ·0000006756, the watts will be

$$\frac{\cdot 0000006756 \times i^2}{w \times \text{depth}},$$

i being the current in ampères. Let T = total rise of temperature, T_1 = conductor rise of temperature, and T_2 = the rise of temperature due to hysteresis and eddy currents. The dimensions of the conductor can then be calculated by the formula

$$w = \sqrt{\frac{c \times \cdot 0000006756 \times \left(1 + \frac{T \times \cdot 388}{100}\right) \times i^2}{\frac{w_1}{w} \times q \times T_1}} \quad \ldots (1)$$

In this formula the increase of watts with rise of temperature is taken into account, but is treated as simple interest only, which is sufficiently accurate for practical purposes.

For an armature in which the watts per square inch were evenly distributed over the whole surface, c would be 33·3 (= reciprocal of ·03) but as the formula relates to the conductors on the periphery, and as in ordinary armatures the watts are not so crowded on the periphery as at the ends and in the hole, it is necessary, in order that the watts per square inch shall average ·03 over the whole surface, to take a higher figure, which may be found by the formula

$$c = \frac{33{\cdot}3 \times \text{length of 1 convolution} \times \text{external circumference}}{\text{total surface}}. \quad (2)$$

The value of c is constant for any type of armature regardless of its size, and is not affected by alteration in the length of the armature.

$\frac{w_1}{w}$ being in the first case unknown, may be assumed at 1·35 and a second calculation made if necessary.

The dimensions of round armature conductors, see fig. 2, are given by the formula

$$d = \sqrt[3]{\frac{\cdot 0000008602 \times c \times l \times i^2 \times \left(1 + \frac{T \times \cdot 388}{100}\right)}{\frac{d_1}{d} \times T_1}}. \quad (3)$$

In this case i is the current in each wire, and l number of layers. As T_2 cannot be calculated theoretically, it has to be estimated from the actual results obtained with previous machines. In slow speed machines it may be as low as 5° C., while in high speed machines it may rise to 20° or 25° C. In alternators having coreless armatures, T_2 practically disappears, and this constitutes one of the advantages of this type of armature.

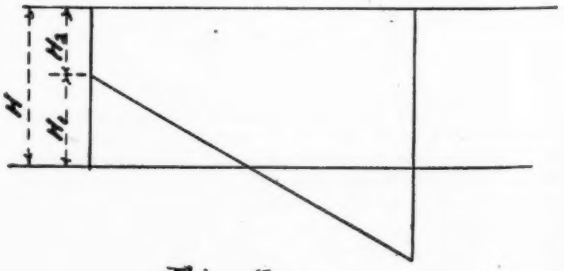


Fig. 5.

In applying the above formulæ to conductors for alternator armatures, the $\sqrt{\text{mean}^2}$ current must of course be taken.

It is not unusual, in specifications for dynamos, to find some given current density specified for the conductors, as though a particular current density carried with it some special virtue. Now as far as temperature is concerned, in a dynamo of which the dimensions are not known, current density has nothing to do with the case. This may be seen

* *Proceedings* Inst. C.E., Vol. cxiv., p. 473; *Journal* Inst. E.E., No. 85, p. 149.

from figs. 3 and 4, in both of which the conductors are of the same sectional area, but as fig. 3 has twice the radiating surface of fig. 4, it may for the same rise of temperature be run at twice the current density.

Sparkless Collection.—In fig. 5, H = the magnetic potential in the gap, H_1 = the magnetic potential necessary to balance the armature cross turns, and H_2 = the magnetic potential required to give a reversing field of sufficient strength to effect sparkless collection. The gap should be so proportioned that the magnetic potential required to give the correct flow of lines for the voltage and speed equals $H_1 + H_2$. If it is less than this figure there will be sparking, while if it is greater the excess constitutes a useless waste of energy. No figures relating to the correct value of H_2 appear to have been previously published. In the dynamos of the writer's design, having ring armatures and wrought-iron magnets, now being made by Messrs. Paterson & Cooper, it has been found by experiment that the ampère turns required to give the proper value of H_2 are 11·25 times the ampère turns per coil on the armature irrespective of the size of machine.

The writer has collated the particulars of a number of drum dynamos of various sizes by different makers, and finds that the ampère turns allowed for H_2 vary from 26·5 to 29·6 times the ampère turns per coil on the armature.

(To be continued.)

A NINETY-SIX TON ELECTRIC LOCOMOTIVE.

With the view, principally, of escaping the nuisance of smoke and gases from a steam locomotive in drawing passenger trains through a long tunnel, the Baltimore and Ohio Railroad, with the co-operation of the General Electric Company, has brought into its service a powerful electric engine, illustrated on our next page. Three of these electric locomotives were ordered, and one of them has for the past few weeks been doing duty conveying passenger and freight trains through a tunnel 7,339 feet long, commencing at the Camden Street depôt, in the City of Baltimore, and over tracks at each end of the tunnel, which brings the total haulage by electric traction up to about three miles. The service calculated upon from these electric locomotives is the transfer of about 100 trains each way daily, each passenger train having a maximum weight of 500 tons, including the steam locomotive connected with the train, to be moved at a speed of 35 miles an hour, and freight trains, weighing 1,200 tons each, to be moved at a speed of about 15 miles an hour on an 0·8 per cent. grade.

The *Scientific American* says that the powerful machine which has been constructed for this work bears with its entire weight of 96 tons, or 192,000 lbs., on its eight driving wheels, which is considerably more than twice the weight on the driving wheels of the heaviest steam locomotive. It has two trucks and eight driving wheels of a diameter of 62 inches each outside of the tyres, the wheel base of each truck being 6 feet 10 inches; the length over all, 35 feet; and the height to top of cab, 14 feet 3 inches.

The cab is of sheet-steel, sheathed inside with wood, and is in two parts, each supported upon one truck. There is a sloping shield on each side of the cab, forward and aft, one shield carrying a head-light and bell, and the other a head-light and whistle.

There are four motors, two to each truck, or one to each axle, and a good deal of the detail of one of the motors is shown in one of the views, the top field frame being lifted away from the armature, and the bottom field frame in position. The driving gear consists of a cast-steel spider, shrunk on, and keyed to, a cast-steel driving sleeve, forming the core of the armature, each arm of the spider having a double rubber cushion with a chilled cast-iron wearing cap, the cushion being forced into the arms of the spider and the cap, and the arms of the spider being thus held in engagement with the spokes of each driving wheel.

The motors are supported on carriers bolted to the field magnets, and rest in adjustable hangers carried on half elliptical springs placed on top of the frame and bumpers. Each motor has six poles and six sets of carbon brushes, the latter being connected to a yoke revolving through 360°, and readily accessible. The field spools are encased in sheet-iron cases, and fitted over the pole pieces bolted to the field frame.

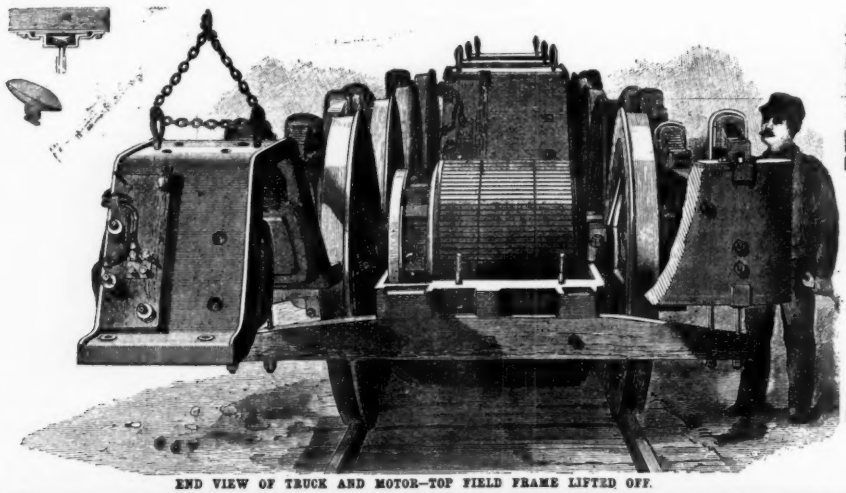
The armatures are built of sheet-iron discs, series drum wound, and known as ironclad, each insulated winding being embedded in an insulated slot cut into the outer surface of the armature body, and held by a wooden key. The armature, with the commutator, is mounted upon and keyed to the hollow sleeve carried on the journals on the truck frame. The inside diameter of the sleeve is about $2\frac{1}{2}$ inches larger than the axle, and when normally placed, the motor rests in a position concentric to the axle, the clearance between the axle and the sleeve allowing a flexible support, and the rubber cushions permitting the armature to run eccentric to the axle when the motor departs from its normal position on account of unevenness in the track. As will be seen by the illustration, the field frame is readily removable for inspection or repairs.

The trolley support, shown in one of the views, is diamond shaped and compressible, contracting and expanding as may be necessary, and leaning to one side or the other as the locomotive runs on one side or the other of the overhead conductor. Contact with the conductor is made by a sliding, shuttle-like brass shoe, shown in a small figure, and the current is brought to the locomotive by cables connected to the shoe and fastened to the trolley support. The conductor is a simple form of iron conduit or trough, erected overhead on trusses outside the tunnel, and in the tunnel attached to the crown of the arch. It is formed of 3-inch iron Z bars, $\frac{3}{8}$-inch thick, riveted to a cover plate $\frac{1}{4}$-inch thick and $11\frac{1}{2}$ inches wide, and is made in sections 30 feet long, weighing about 30 lbs. per foot. The insulation of the conductors is effected by conical porcelain insulators, supported in transverse frames, and the supports of the frames are themselves similarly insulated where they are secured to the arch of the tunnel, thus affording a double insulation. The feeder cables are of bare standard copper of 61 strands, each of 1,000,000 circular mils (1 inch) cross section.

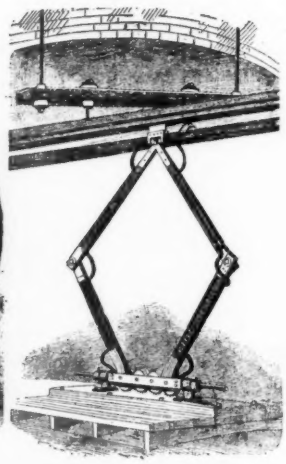
Each motor is rated at 360 horse-power, and takes a normal current of 900 ampères at a pressure of 700 volts. The controlling devices and measuring instruments occupy the interior of the cab, the controller being of the series parallel type. Above the controller are the instruments which tell the driver the amount and pressure of the current the motors are taking, and a slot in the floor enables him to keep his eye on the commutators. The reversing lever projects through the upper plate of the controller cover, and the resistances are placed around the frame beneath the floor of the cab. The locomotive is equipped with a 1,200 to 3,500 ampére automatic circuit breaker and one 2,000 ampère magnetic cut-out, a 5,000 ampère illuminated dial Weston ammeter, and one illuminated dial Weston voltmeter. The compressed air for the whistle and brakes is supplied by an oscillating cylinder electric air pump, the air tanks being placed at each end of the complete locomotive. The interior of the cab is illuminated by clusters of incandescent lights.

The power house, which is also equipped with an electric lighting plant for lighting the tunnel, is in the immediate neighbourhood of the tunnel entrance, and is 30 feet high and 322 feet long. It has an engine room 223 feet long × 57 feet wide, and the dimensions of the boiler house are 98 × 69 feet. In the latter, in six batteries, are 12 250-horse-power Abendroth & Root water tube boilers. Five engines and generators have been provided for, and four are now in place. The engines are of the tandem compound Reynolds-Corliss type, and have 24 and 40-inch cylinders. Directly coupled to them are 500 kilowatt General Electric multipolar generators, adapted to run with the engine at 110 revolutions a minute, and from these generators the current is taken over cables of 1,000,000 circular mils (1 inch) cross section to a switchboard on a platform at the south end of the engine room. From the positive receiver or bus on the switchboard eight cables of stranded copper pass to an overhead structure immediately outside the power house, where connection is made to three feeder cables and to an overhead conductor. The negative bus is similarly connected to the the rails, which are double bonded with No. 0000 wire, and also to return cables laid in a wooden box between the tracks.

The tunnel, for use in which this locomotive was built, runs under Howard Street, one of Baltimore's principal thoroughfares, and was driven without any interference to the surface traffic, the vertical shafts being sunk to the tunnel through the cellars of houses along its line. The only severe cave-in occurred in the vicinity of the Baltimore City College, which was ruined. A new college was built by the contractors on the site of the collapsed building. Work on the tunnel was begun in September, 1890, and it was finished early this year. It is 27 feet high and 22 feet wide, and cost $7,500,000.



END VIEW OF TRUCK AND MOTOR—TOP FIELD FRAME LIFTED OFF.



THE TROLLEY CONNECTION.

THE NEW ELECTRIC LOCOMOTIVE OF THE BALTIMORE AND OHIO RAILROAD COMPANY.

PRODUCTION UP TO THE POWER LIMIT.

At the seventh annual general meeting of shareholers in Crompton & Co., Limited, on the 9th inst., Mr. Kitchin remarked that he heard a good deal about electrical business in the City, and he had been informed that of all firms that went in for "cutting" contracts, Crompton & Co. were the very worst. In his opinion they were over-trading, and it was useless to do so much work if it did not yield a profit. To this Mr. Crompton replied that it was very difficult for any firm to get profitable contracts unless they took financial

risks; in all ordinary cases the profit was very small indeed. Viscount Emlyn, the chairman, coincided with Mr. Crompton, and declared that business could not be obtained unless the tender was very low.

It has long been known that electrical manufacturing and contracting firms are doing their level best to cut the ground from under each others feet by accepting work at ruinous prices, and there are not a few, who, carefully watching the game, are ready to prophesy the collapse of more than one big firm in the near future.

Dynamo makers do not hesitate to openly avow that it is difficult to get 5 per cent. profit on their wares; many wiring firms seem to undertake contracts on a basis which, for the complete fitting up of premises, will not really cover the cost of the best class wire alone; incandescent lamp manufacturers are fiercely competing at ever diminishing prices, and it will soon become a question of seriously considering the best course to adopt in order that the electrical contractor can secure "a living wage."

There is one factor, however, which is of vital importance in the cheap, yet good, production of electrical appliances of the heavy order, which, we think, has not received much consideration amongst English manufacturers, or at all events from electricians who have combined the practice of mechanical engineering with that of their own special vocation. We refer to production up to the power limit.

It has been very forcibly and tersely brought to the notice of Americans, and it is equally deserving of careful thought on this side.

In the *Engineering Magazine* for August, Mr. Horace L. Arnold instances a machine shop having the best plant procurable, which means a large investment in lathes, planing, slotting, shaping, and milling machines, and, in addition, a considerable number of special machines, adapted to the shop's individual requirement. This plant is supposed to be in charge of a superintendent, works' manager, foreman, or what you will, who is given to fully understand that he, and he alone, must make the concern a commercial success.

The problem, then, to be considered is, what should be his policy regarding the use of his fine and costly machine tools?

Shall he use them carefully, taxing their productive powers well within the endurance limit, and having their preservation and long life always in mind, or shall he regard them merely as a means to an end to be used to their utmost power limit, regardless of the effect upon their nicely-fitted organisations?

It is perfectly well-known that machines have their limit of endurance, and, at a casual glance, it would seem that the first suggested policy would be best; but, on the other hand, regarding his machinery as means to an end, shall he seek the speedy accomplishment of that result, and work his apparatus up to the limit of their productive powers? It will, naturally, be understood that in the latter case no obvious abuse of the machine tools is to be permitted.

Mr. Arnold then commences to make comparisons of the two policies, and gives the following example as a start off:

Suppose a shafting lathe can finish 200 feet of shafting a-day for 20 years before it needs a rebuild; suppose also that it has power enough to turn 400 feet of shafting per day if urged to the utmost; in this case, if the lathe ran 10 years on the last-named daily production, it would give the same total result as if its life had been doubly prolonged by easy usage.

But, when considering the commercial side of this performance, it is seen that, while the total output is the same in each case, the work done by the carefully used and long-lived tool has cost twice as much in wages, twice as much in insurance, floor room, and all fixed charges, as a lathe worn out in half the time. Hence it is clear that where the careful tending of tools make the product more costly than if the plant were urged to its full capacity, they are never money makers; their production is never great enough to warrant their existence, and the shop carefully managed to this extent must go out of business.

A second example given by Mr. Arnold is that of a lathe costing $500, and lasting 10 years. With money at 5 per cent., the yearly cost of this tool is $75 ($25 was evidently intended, from the figures which follow) for the bare machine itself. It may occupy a floor space of greatly varying rent value; perhaps as little as $15 yearly. The labour figures are much larger; the lathe hand may be paid $1.50 per day, or $2.00, or even $3.00. If his pay is $2.00 per day, it is $600 for 300 days, or a year of working time; then for 10 years of lathe work, as specified, the shop pays $500 for the lathe, $250 interest, and $150 rent, and, perhaps, another $100 or so for other fixed charges; or, say, $1,000 for the 10 years' life of the $500 lathe. But in the same time the shop has paid out $6,000, or six times the machine-tool outlay, for labour to operate the tool. The total expense for the 10 years of assumed lathe life and use is $7,000, of which only $1,000 is chargeable to the machine-tool account. Suppose, now, that, by driving this same lathe to the utmost limit of its belt pull, it had been forced to double its output, and had lived for only five years of service. This gives the same total product as before, at a machine-tool, rent, and interest cost of only $750, and a labour cost of $3,000, making a total of only $3,750 paid for the work as against $7,000 paid for the work of the same tool with double the life; hence the profit on the output might be very great if the machine tool were destroyed quickly, as against nothing at all if the lathe were worked at an easy rate.

This simple example makes it very clear that accuracy, finish, close fitting, and easy handling—the distinguishing points of American machine-tool production—are not enough in themselves to insure the commercial success of the users of such tools. To these most desirable American features the commercially successful machine tool must add a great metal-removing capacity; the greater the better, unreservedly. Hence the constant additions to weights of American machine tools for equal capacities, and the equally steady increase in the driving power given to tools of nominally the same sizes. Hence, too, good practice clearly demands the prompt retirement of such machine tools as are incapable of comparatively large production. They may be still in good condition, and yet cannot be kept in use by any concern intelligently seeking commercial success.

Shall the superintendent, then, drive every tool in his charge to its utmost limit of production as fixed by the width and speed of its driving belt?

Assuredly yes, if they are to make money.

Mr. Arnold states that the cost of labour is so very great in proportion to machine-tool cost in all machine-shop operations, that the life of the machine-tool is not an element to be considered at all, and that with the larger and more expensive class of lathes, planing machines, and machine tools generally, there is no danger at all of injury through over-driving.

He finally instances the Baldwin locomotive shops, which cover several squares in Philadelphia, accommodate 5,500 men, are the largest in the world in their line, and pay the highest rate of wages anywhere to men in similar employment. Yet the work is done very cheaply, and, in many cases, at incredibly low prices.

Summed up in few words, the Baldwin shops' theory appears to the writer to be this: Every machine tool has, when new, a fixed metal-removing potentiality, and can cut a certain number of cubic inches of iron or steel or brass into chips before it is worn out; and the sooner it can be forced to cut those chips, the sooner it has reached the end of its total earning powers, and the sooner it has brought in its profits.

The mechanical and commercial success of the Baldwin establishment, its continuance and constantly increasing growth, while generations of its managers pass away, and the contentment of its workmen give the strongest possible testimony to the correctness of its internal policy, it must be held as proved that machine tools should be regarded and treated as containing certain total possibilities, which are most profitably exhausted in the most rapid manner possible; that it is an error to prolong the life of a machine tool by light performance demands; and that the sooner a tool is worn out in effective production, the better and more profitable the management under which that machine tool was carried through its useful career from the hands of its maker to the scrap heap.

It must not be supposed that we have exhausted Mr. Arnold's arguments; we have but put forward the gist of his contentions to those who peruse these pages, many of whom would do well to read, learn and inwardly digest the complete article, and so gain both pleasure and profit.

THE COUNTER ELECTROMOTIVE FORCE IN THE ELECTRIC ARC.*

By W. H. FREEDMAN, E.E.

There having been for a long time considerable discussion and difference of opinion regarding the counter electromotive force of an arc, an experimental investigation was undertaken with the hope of throwing some light on the subject.

Some writers go so far as to totally deny its existence; while others claim it must be present, on account of the chemical change of the electrode.

Those claiming its existence, however, do not all express the relations between it and the other quantities involved by the same formula, as a few cited cases will show.

Edlund † $E = a + b c l.$

S. P. Thompson ‡ $E = a + \frac{b l}{c}.$

Cross & Shepard § $E = a c + b c l.$

Frölich ‖ $E = a + b l.$

Lang ¶ $E = a + b c l.$

In all of which

E = difference of potential between the electrodes,
a = counter electromotive force,
b = a constant,
c = the current,
l = the length.

A few preliminary observations showed that we were dealing with three quantities, in some way related to each other, *i.e.* :—

(*a*) Difference of potential between the electrodes or voltage.

(*b*) Current.

(*c*) Distance between the electrodes.

If either one of these quantities were varied, the other two changed also.

To clear up this relation it was decided to proceed as follows: Take the reading of a Weston voltmeter connected to the electrodes for different distances between the electrodes, keeping the current as read by a Weston ammeter constant by means of a variable resistance.

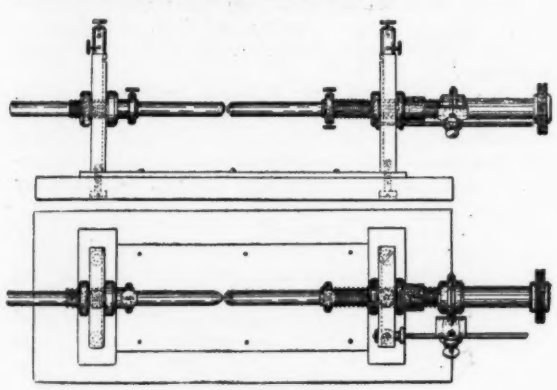
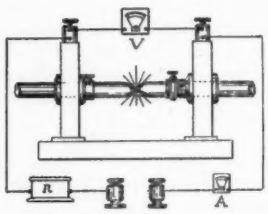


Fig. 1.

To measure the distances, the apparatus as shown in fig. 1 was constructed. It consists of two metal sides in the centre of each of which there is an opening into which fits a tube of one-half inch internal diameter. The left hand tube is fixed and is not much longer than the thickness of the metal side. The right hand tube is quite long and has a screw thread cut upon it, so that by rotating it the distance of its end from the left hand side is varied. Both tubes are split on the end and carry collars with set screws. Into these tubes can be fastened any set of a number of interchangeable electrodes, and with careful adjustment properly aligned so that the only effect of rotating the right hand tube is to draw the electrodes apart. The right hand tube is provided with a collar, coming to a sharp edge, whose circumference is divided into five parts. A metal rule graduated to twentieths of an inch can be slid back and forth on a slender brass rod so that its zero reads the initial position of the edge of the collar. As the screw thread on the tube is accurately made, 20 threads to the inch, we have a means of reading distances to 100th of an inch.

The connections were made as shown in fig. 2.



Terminals.

Fig. 2.

By keeping the ammeter reading constant, the readings of the voltmeter were noted with different distances for various electrodes. Repeating each set of observations a number of times, and taking the average voltmeter readings, Table I. was constructed.

The current was kept at one ampère.

The first column gives the distance in 100ths of an inch between the electrodes.

The other columns give the voltmeter readings for that particular electrode at the distances between electrodes in the first column.

Table I.—Current One Ampere.

Distance.	Brass.	Zinc.	Iron.	Steel.	Copper.	Lead.	Carbon.
1	25·00	19·89	23·00	23·50	27·00	17·00	42·00
2	29·30	24·67	29·71	31·00	31·67	20·75	47·25
3	34·10	27·63	34·00	36·00	36·67	25·00	54·25
4	38·40	31·38	38·86	40·00	40·67	28·67	59·50
5	41·80	35·25	42·86	44·00	45·33		66·00
6	44·50	38·63	46·67	47·00	48·67		71·50
7	47·60	41·25	50·00		51·00		75·50
8	50·00	43·75	53·00		54·20		79·00
9	52·00	46·00					81·60
10	55·00	48·50					86·00
11							88·75
12							92·00
13							96·50

With a view to more clearly grasp the significance of these figures, a number of curves were plotted, taking the distances as abscissæ and the voltmeter reading as ordinates. These are shown in fig. 3.

If we consider these curves, we of course note that each substance apparently follows a law of its own, but that the curves diverge but little from straight lines, and that only gradually and slowly.

Admitting the existence of a counter electromotive force, we can start with this fundamental equation: The difference of potential between the electrodes of the arc is equal to the counter electromotive force plus the drop due to the current, or

$$V = x + C R.$$

If the counter electromotive force is a constant quantity for each current, that is independent of the length of the arc, we see that its value would be the intercept on the axis of Y. From our equation

$$V = x + C R$$

we further note that if we moved our origin up so that it would be at the height of the intercept, our curve would have the equation then :

$$V - x = C R,$$

or plotted show the curve of drop only.

* *Electric Power.*

† E. Edlund, *Poggendorff's Annalen*, No. 134, p. 280, 1868. *Wiedemann's Annalen*, No. 26, p. 518, 1885, and No. 28, p. 560, 1887.

‡ L. Duncan, *Elec. World*, Vol. xxii., No. 6, p. 101, August 5th, 1893.

§ L. Duncan, *Elec. World*, Vol. xxii., No. 6, p. 101, August 5th, 1893.

‖ O. Frölich, *Elektr. Zeitschrift*, No. 4, p. 151, 1883.

¶ *Elektr.*, No. 7, p. 443, 1885, and No. 9, p. 566, 1887. *Elektr. Zeitschrift*, No. 8, p. 12, 1887.

Since current C is one ampère, this curve must be the curve of resistance of the arc.

This compels us to conclude that the resistance of the arc is not a constant quantity, but changes with the distance between the electrodes, even if the current is kept constant. Since the curvature is slight and gradual, the equation of these curves can be expressed empirically by the powers of the abscissæ, thus :

$$y = a\,x + b\,x^2 + c\,x^3 + d\,x^4, \text{ \&c.}$$

There will be no constant term as the curve passes through the origin.

Furthermore, for simplicity, let us only keep first and second powers of x, as formula can only be at best, approximate.

Consequently let us assume the equation

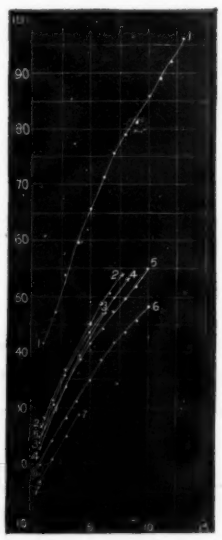
$$\text{R} = a\,d + \beta\,d^2,$$

where

R = ohmic resistance,

d = distance between the electrodes expressed in 100ths of an inch.

a and β = constants to be determined such as to satisfy the assumed relation.



= carbon. 2 = copper. 3 = steel. 4 = iron. 5 = brass. 6 = zinc. 7 = lead. Ordinates are volts. Abscissæ are hundredths of an inch.

Fig. 3.—One Ampere Curves.

According to this assumption, our fundamental equation

$$\text{V} = x + \text{C R}$$

becomes $$\text{V} = x + \text{C}\,(a\,d + \beta\,d^2),$$

or, $$\text{V} = x + d\,y + d^2\,z.$$

Taking this then as our fundamental equation, we can construct observation equations which solving by Least Squares gives the most probable values for x, y and z.

Table II.—Current One Ampere.

Material.	x	y	z	Formula of resistance.
Carbon ...	34·94	+ 6·96	− 0·18	$6{\cdot}96d - 0{\cdot}18\,d^2$
Brass	20·12	+ 5·12	− 0·169	$5{\cdot}12d - 0{\cdot}169d^2$
Copper ...	17·46	+ 6·72	− 0·23	$6{\cdot}72d - 0{\cdot}23\,d^2$
Steel	17·17	+ 7·43	− 0·413	$7{\cdot}43d - 0{\cdot}413d^2$
Iron	17·13	+ 6·44	− 0·249	$6{\cdot}44d - 0{\cdot}249d^2$
Zinc	15·59	+ 4·53	− 0·125	$4{\cdot}53d - 0{\cdot}125d^2$
Lead	12·89	+ 4·09	− 0·032	$4{\cdot}09d - 0{\cdot}032d^2$

Accordingly the regular tables for the formation of Normal Equations were constructed and the normal equations for each substance formed. The solution of these equations gives the counter electromotive force and the resistance of the arc for one ampère of current.

The results are given in Table II.

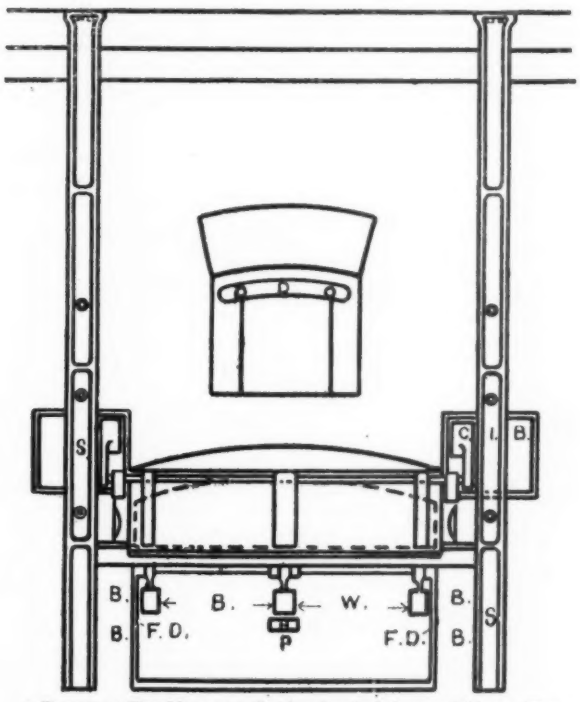
(To be continued.)

DUST DESTRUCTORS AND ELECTRIC LIGHTING.

II.—St. Pancras.

The Vestry of St. Pancras have now completed the construction of the necessary buildings to accommodate the plant required for a second electricity generating station on a site in King's Road, Camden Town. The intention, when this station was projected, was to erect 18 destructor cells, to which would be delivered the house refuse, if not of the whole parish of St. Pancras, at any rate, most of it, for destruction by fire, and the works have been laid out so that the heat produced by the combustion of the refuse may be utilised in raising steam to be put to useful purpose in the central station.

The cells are designed on considerably different lines to the prevailing types, the objects sought being a regular and continuous supply of refuse to the fires with the least amount of hand labour, and to obtain the most perfect consumption with as large a quantity of refuse as possible. To secure these results a form of fire-bar, with mechanical action, has been adopted, and provision is made for applying forced draught by means of fans ; but this is rather with a view to balancing the draught in the fires, which are not all situated in the same relation to the chimney.



D, Damper; S, Stanchion; C I B, Cast-iron box for balance weight; B B, Blue bricks; F D, Forced draught; B W, Balance weights; H, Handle; P, Plate hung on hooks.

Front Elevation.

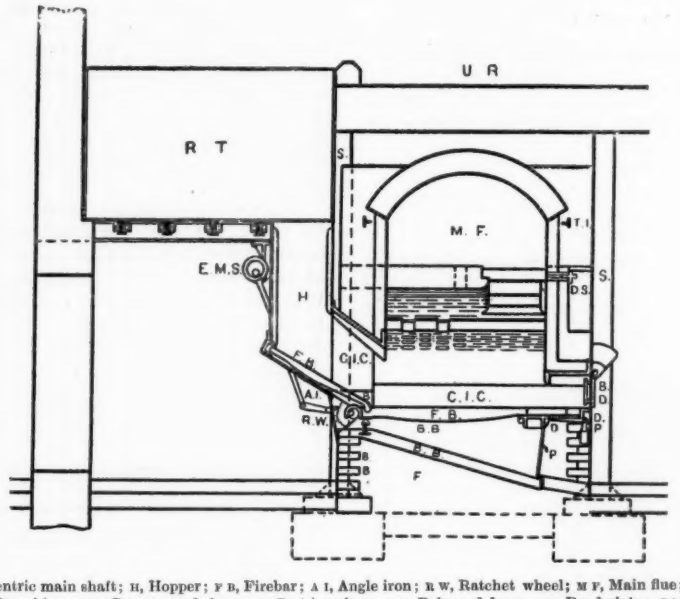
The refuse is delivered by an upper roadway, and discharged into tanks along the sides of the roadway, each tank being continuous over six cells, to which communication is made by hoppers or shoots. At the bottom of the shoots the refuse finds a resting place on bars connected by a knuckle joint with the fire bar proper. These two sets of bars, with their bearings and motors, are the subject of one of the patents of Mr. B. D. Healey, of the Municipal Appliances Company, Limited. The motion of the bars is imparted by a shaft on eccentric bearings, upon which alternate bars rest, while the other half are carried by a fixed bearing, and all the bars rest on a fixed dead plate at their front ends. The effect of this arrangement is to lift the fire off the fixed bars and carry it forward 2 inches, which is the throw of the eccentric shaft. A similar movement is imparted to the back bars from the knuckle joint formed in the main bars, so that the refuse from the hopper is pressed forward into the furnace,

and is carried through the furnace at a rate found suitable for effecting perfect combustion. In front of the dead plate is a balanced door, to allow the escape of clinker from the furnace, so that from the delivery of refuse on the hoppers in the tank to the picking up of the clinkers on the floor, no hand labour is required.

The cells—of which some views are given in the accompanying illustrations—are 5 feet 3 inches long by 5 feet wide by 2 feet 6 inches high for inside dimensions, and are constructed of fire-brick, the arch being perforated to allow the gases to escape to a combustion chamber, and hence to the flue, which passes along over the cells. Any cell can be shut off for repair or disuse, by inserting a damper in the opening between the combustion chamber and the flues. On each side of the fires hollow cast-iron cheeks are built in; this is to permit the free movement of the burning refuse, as it has been found that by burning in to the fire-brick sides, and the consequent increased use of the firing tools, the sides required more frequent repair than would otherwise have been necessary.

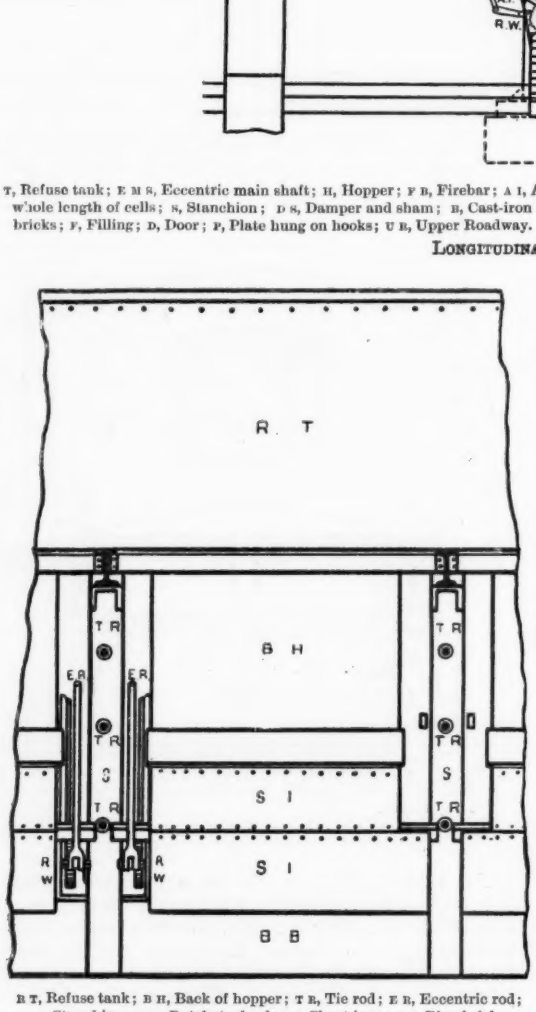
The blocks of cells are erected between two rows of stanchions, with bolts passing through the whole structure; all the facing of the cells and flues is of fire-brick, and of the ashpits of Staffordshire blue bricks.

The general work on the site, and the work in connection with the destructor cells and buildings has been executed under the directions of the vestry's engineer, Mr. W. N. Blair, and the electrical portion of the works, comprising boilers, engines,



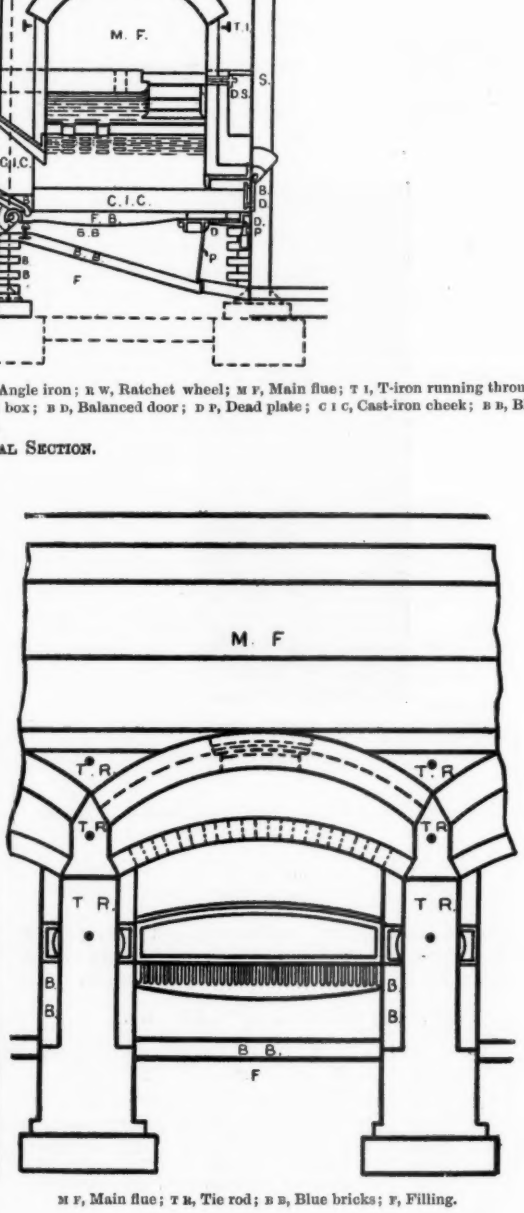
R T, Refuse tank; E M S, Eccentric main shaft; H, Hopper; F B, Firebar; A I, Angle iron; R W, Ratchet wheel; M F, Main flue; T I, T-iron running through whole length of cells; S, Stanchion; D S, Damper and sham; B, Cast-iron box; B B, Balanced door; D P, Dead plate; C I C, Cast-iron cheek; B B, Blue bricks; F, Filling; D, Door; P, Plate hung on hooks; U R, Upper Roadway.

Longitudinal Section.



R T, Refuse tank; B H, Back of hopper; T R, Tie rod; E R, Eccentric rod; S, Stanchion; R W, Ratchet wheel; S I, Sheet iron; B B, Blue bricks.

Back Elevation.



M F, Main flue; T R, Tie rod; B B, Blue bricks; F, Filling.

Cross Section.

dynamos, and the houses for them, has been up to the present directed by Prof. Henry Robinson, who has for some years advised the vestry on electrical matters. Extensions and maintenance will in future be under the joint control of Mr. Blair and the chief electrical engineer of the vestry, Mr. Sydney Baynes. Considerable interest attaches to this destructor station, as it is on lines rather off the beaten track.

CORRESPONDENCE.

Calvert's v. Green's Economiser.

Referring to the article in your number of August 2nd, entitled "Economic Tests of Economisers," without further commenting on the fact that the supposed Calvert's circulation economiser was *not* made by my company, but was an imitation which Messrs. Green had made, I would beg you to kindly allow me to reply to your own expression of opinion as regards making the economiser in a few blocks instead of circulating through each section consecutively as on my system, your principal reason for this being excess of friction on my system.

I can only suppose that this opinion is based on a misimpression as to the extent of this friction. Now in the largest economiser it need not exceed 10 lbs. super-pressure on the feed pump; in fact, if it be demanded as a *sine quâ non*, I will undertake not to exceed 5 lbs., although by going to the extent of 20 lbs. or so I hold that a favourable effect is produced by the strong rush of water through my patent injector nozzles causing a lively action in the water, which is favourable not only to the better conduction of heat, but also lessens the tendency for scale to settle inside the pipes. This latter advantage alone has already proved itself to be invaluable where my economiser has been at work in a chalky neighbourhood, where the old form of economiser is practically prohibited.

I think you will admit that 5, 10, or even 20 lbs. extra work on a feed pump is quite a negligible quantity, and that, if the principles of circulation and counter-current are good, then such a trifle of friction ought not to stand in the way of their being applied to their fullest extent.

Of course I must ask you to accept my statement as to the extent of the friction, which I am prepared to prove on scores of economisers working under all manner of conditions.

James G. Calvert.

Calvert's Circulation Economiser Company,
24, Exchange Buildings, Manchester.

The Megohm.

I am at present endeavouring to obtain a few days' relaxation from business, but I find a question which seriously affects the well-being of the whole electrical industry weighing heavily on my mind, and as I know that whilst you are principally engrossed in science other matters not less important will not, by reason of their being more common-place, fail to secure your best attention and support, I write to solicit your kind assistance in the solution of the said question.

The question is, can we not find some better means of specifying the qualities of insulation of conductors than by the mere quotation of so many thousand megohms per mile for a whole class containing many different diameters and therefore many different areas of insulation?

What we want, for instance, in a system of town mains, is, first, a definition of the resistance of the dielectric reduced to Preece's quadrant cube, or to one acre one inch thick, or any other suitable and convenient standard. Secondly, a definition of the thickness of the said dielectric to be placed around every cable to be included in the system. Thirdly, a test to show that each cable possesses an insulation resistance in megohms corresponding with the quality, thickness, and area of the dielectric chosen.

I imagine, Sir, that with a specification based on these lines it would be possible for a borough electrical engineer in charge of a constantly extending system to obtain something like uniformity in the strength and quality of his insulation, which I think he is nearly, if not quite, powerless to obtain by the existing method.

By the existing method we may get many things which we do not want. Firstly, we get a pile of megohms greatly in excess of our needs. Secondly, we may get extra thickness and inferior quality. Thirdly, we may get inferior quality without extra thickness, for the manufacturing experts inform us that the megohms are not a test of quality. I have no doubt that you, Sir, know exactly what they do indicate, and what the process is whereby cable makers are able to artificially increase resistance, thus taking away from the megohm as an index of character, the last shred of virgin innocence.

For my own part I am free to confess to complete ignorance of the ways and wiles of cable makers; I know nothing but what they have told me either verbally or through their price lists, and probably it is well that my education has stopped at this point, not that I wish to accuse them of insincerity, on the contrary, my inclinations are all the other way, for in 17 years' experience I have only had two bad cables, but there can be no possible doubt whatever that this immunity from disaster has been purchased at the cost of excessive insulation due to a state of ignorance in myself and others, clearly attributable to the present illogical method of specifying insulation.

Let me give you one or two instances of the ramifications of this manufactured ignorance.

A few weeks ago I received an indent for a quantity of 7/20 leading-in wire for transformers, specified 2,000 megohms. From your intimate knowledge of the cable business you will readily believe that I did not send on the order according to specification. On consultation, the makers advised 5,000 megohms, but I replied that on so small a cable I should expect 10,000, to which they immediately agreed, but if the order had been sent out for 2,000 megohms we should have had no redress if we had received a very inferior cable.

Again, it is a very common experience to find electric light committees, in examining tenders for cables, carried away entirely by the number of megohms guaranteed, although the dielectrics tendered for may be so diverse as vulcanised rubber, paper, bitumen, or Mavor's compound.

I hope, Sir, I have said enough to show the desirability of some improvement, but as to the exact means of obtaining that improvement, you are a better judge than I, and I hope there will be a free expression of opinion, as I like a man who speaks his mind, if his method be in the least degree artistic and not merely brutal.

John S. Raworth.

Southport, *August 17th*, 1895.

Your article in the last issue of the REVIEW is an opportune reminder that "insulation" should "insulate." At one time it was my privilege to be told almost daily that the principal, if not the only, use of insulation was to keep the conductor it surrounded at a little distance away from other conductors. Of the two classes of extremists I think those least likely to encounter trouble who ask for insulation, and see that they get it. At least so experience would teach. The following extract from my note-book, taken from the REVIEW, Vol. xxii., p. 689, shows that you fully appreciated the position years ago.

"The relative figures of volts in the case of pressure and megohms in the case of resistance are not generally very clearly comprehended. With regard to the disruptive pressure, this is practically the same at every point of the length (of a cable) no matter what the latter may be. With the dielectric resistance, the case is perfectly distinct and different. It is obvious that we can arrive at the conclusion that an infinitely thin covering can effectually resist an infinitely high pressure, but here the question of 'striking distance' comes in, and it is, therefore, really the thickness of the dielectric that determines finally the resisting power of the same. Strictly speaking, therefore, the insulation resistance should be accepted as the standard only in so far as it determines the thickness of the dielectric."

Charles H. Yeaman.

August 19th, 1895.

Dust Destructors and Electric Lighting.

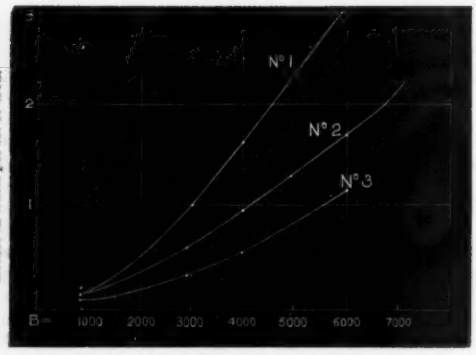
We notice a slight error in the article in your issue of the 16th inst., on "Dust Destructors and Electric Lighting" for the Vestry of Shoreditch, which is being carried out by us as the Vestry's consulting engineers. You state that "an extensive use of *alternating* current motors is contemplated;" but as a matter of fact, owing to the conditions of distribution in Shoreditch, we have adopted the *continuous* current system, and therefore obviously such motors will not be used.

Kincaid, Waller & Manville.

August 20th, 1895.

Iron Losses in Transformers.

On comparing the curve (fig. 5) of iron losses given on page 124 of your August 2nd number, with the curve given on page 24 of Weeke's "Alternate Current Transformer," I found a considerable difference existed, and with the idea of seeing which was right, I turned to Vol. ii. of Fleming's "Alternate Current Transformer," page 490, Formulæ Nos. 16 and 20, and calculated the iron losses from those formulæ, and found the result differed from both the curves which I had compared.



I have plotted the results out for the sake of comparison, and enclose them.

Curve No. 1 is from Prof. Fleming's formula.
" " 2 " Weeke's book.
" " 3 " (Adams) ELECTRICAL REVIEW.
The hysteretic constant taken was ·0045.
Thickness of iron, 10 mils.
Periodicity = 100 per second.

Thinking this might be of interest to you, and that you will be able to assist me in elucidating this problem,

Student.

August 20th, 1895.

Electrical Communication between Lightship and Shore.

In reference to the description of a method for communication between lightships and shore, abstracted from *Engineering*, and which appears in your journal of the 16th current, the said method does not appear to possess any novelty, except, as you remark in your leader on the subject, in the apparatus employed; Mr. Preece and others having already carried out successful experiments in this direction.

In respect to the apparatus, the introduction of a sensitive relay is by no means new, such being now employed in the signalling arrangements, on the non-continuous system, between Crookhaven and the Fastnet Rock, to which system you refer favourably.

The manner in which communication is established in this case is substantially similar to that described by Mr. Willoughby S. Smith in 1893, in referring to trials made between the Needles Lighthouse and the Isle of Wight. These trials were not successful. The telephone had to be substituted by a mirror-speaking instrument, and it was said to be found necessary to call attention by means of visual signals before operating the instruments. The Post Office authorities subsequently replaced this discontinuous by a continuous cable.

The purpose of a relay in the Fastnet scheme is to call attention by closing the circuit of a local battery and ringing a bell, a D'Arsonval mirror-speaking instrument with a line battery of five cells being the medium through which signals are read.

On the completion of the laying of the cable towards the Fastnet, signals were, I understand, transmitted temporarily by means of the lightning conductor. The relay answered perfectly on shore at Crookhaven in ringing the bell, and the signals, on bell being cut out, were received clear and distinct.

So far, so good; and in all probability better when earth plate and copper conductors on the Rock are permanently fixed, but, as you pertinently remark in your article, "a cable lying slack on the bottom would probably be easily moved out of its position by action of tides." There are other forces than tides. The tremendous action of the sea at and near out-lying rock stations is sufficient to dislodge a mushroom anchor, attached though it may be to a stout conductor in connection with the main cable. However carefully a light cable may be payed out from a boat or a raft, there must be a good deal of slack on this terminal connection to the mushroom.

These forces, in a measure, apply to rings of cable laid around the area over which a lightship swings, and which, as you point out, would require to be more than half-a-mile in circumference. This, in the case of a lightship riding to a single anchor. With a vessel moored, as many are now on our coast, with two arms of 210 fathoms each laid along the axis of the tidal stream, and two other arms of 150 fathoms each at right angles to the others, or thereabouts, to enable cable communication to be established with them, the inductive telegraph cable ring would need to be laid around over the moorings in order to bring the coil within the area of the lightship's swing, which is, of course, much restricted. It may be said that these extra moorings could be dispensed with in the inductive circuit system, but the fact remains of the necessity to veer away chain during bad weather.

A closer consideration of the subject would, moreover, show that the employment of the telephone as a speaking instrument in the case of lightships is a *sine quâ non*, for, the practical man on board a lightship during a gale of wind wants everything to be made as simple as can be, and he can't follow visual signals on a "mirror" with his cockle shell of a ship describing a rolling angle of 20° as many times in a minute.

In concluding your article you touch upon the utilisation of the lightship's chain as being better than an actual break in the circuit. This method was suggested in a paper read by me in March, 1892, at St. James's Hall, a *résumé* of which you published in your issue of March 25th of that year, and it is, in the opinion of other practical electricians, quite feasible.

There is so much that might be said upon this interesting subject that I am fearful of trespassing upon your valuable space. A few words more upon inductive methods generally, from the researches of Mr. Preece alone, will engender doubts in the minds of the most sanguine and ingenious advocates of this system for lightships.

In giving an account of experiments carried out between the Island of Arran and Kintyre, before the British Association at Oxford in August of last year, Mr. Preece, according to his paper, says that "There are many disturbing elements introduced, geological as well as electrical, and that remarkably concordant and accurate results have been obtained in one locality, but equally discordant results in another."

H. Benest.

August 20th, 1895.

THE EFFICIENCY OF WORM GEARING CONNECTED TO ELECTRIC MOTORS.

In a paper read before the Electrotechnical Society of Vienna, Mr. Ernst Egger described, with the aid of illustrations, various kinds of electrically-operated lifts. The author stated that when worm gearing was employed for transmitting the power direct from the motor shaft to the drum, it was particularly advantageous to use low speed motors. This expression of opinion has elicitated a response

from Mr. Emil Kolben, of the Oerlikon Engineering Works, who flatly contradicts that assertion in the *Elektrotechnische Zeitschrift* of August 15th.

In correcting this erroneous idea, which has generally been held, Mr. Kolben states that high speed motors should be exclusively adopted in conjunction with worm gearing, if the work is to be commercially practicable, and a good efficiency realised. It is from this standpoint that the question is of importance to electrical engineers, since, although no particular difficulties are met with in the construction of motors to run at low speeds, yet the motors are heavy, bulky, and expensive, so that the use of such motors in many cases is excluded. As, on the one hand, the employment of worm gear is regarded with great mistrust, and yet, on the other, this kind of gear is the most important reducing mechanism for electrically-driven tools, cranes, and lifts, and for vehicles, Mr. Kolben thinks it right that some facts should be adduced for the benefit of the electrical industry.

Proceeding to deal with this question, the author points out that a great prejudice against worm gear has hitherto existed, on account of its having been regarded in the old text and hand-books as an inefficient means of transmission; and not unjustly so, when the method of constructing the gear is considered. After referring to the work in this direction by Profs. Thurston and Kimbal and Mr. Tower in the United States, and by the late Mr. A. Reckenzaun, who obtained an efficiency of 87 per cent., and subsequently by Mr. Sellers, in Philadelphia, the author discussed the efficiency tests recently carried out by Prof. Stodola, of the Zurich Polytechnic, with the ordinary double thread worm gear of the Oerlikon Engineering Works.

The worm was 80 mm. in diameter, had a multiple ring bearing and engaged with a worm wheel having 28 teeth, the wheel being of bronze, 373 mm. in diameter. The whole of this gear was placed in oil in a cast-iron box. The gear was coupled to a 20-H.P. electric motor, and the breaking tests were made on the worm wheel shaft. The results were as favourable as in the case previously mentioned. At 1,500 revolutions, a useful performance of 21 H P. was given on the brake, the efficiency amounting to 87 per cent. The author, who had previously conducted a series of experiments which agreed with the result above cited, is of opinion that the efficiency with the motor fully loaded, will increase even beyond 90 per cent., if the following points are considered in the construction and fitting up of the gear for direct coupling with electric motors.

1. The starting speed should, according to the output, amount to from 6 to 12 metres per second, instead of from ·5 metre to 2 metres, as has hitherto been customary. This condition necessitates the use, not only of high motor speeds, but also of a large diameter of worm, and consequently great distances between the teeth, powerful teeth, and ample bearing surface. By this means the total friction will be reduced. For the purposes mentioned the motors required range from 2 H.P. to 25 H.P., with usual speeds varying between 1,600 to 800 revolutions a minute. As the lift drums to be operated, the driving spindles of machine tools, and the car axles of tramcars, have speeds of from 150 to 40 revolutions a minute, it is possible to obtain in the most simple manner, without any intermediate gear, the whole speed reduction by means of worm gearing, with a single or double thread worm having a ratio of reduction of 10 to 1 or 20 to 1.

2. The mechanical production of worm gear requires the greatest care, if it is to be useful for the direct coupling of motors. The worm must be turned out of a solid piece of tool steel, and be tempered, smoothed, and polished. The crown of the teeth should be made of hard phosphor bronze, and if of large diameter, it should be drawn hot on to a cast-iron arm crown. The teeth are to be properly cut and polished. The whole gear is to be enclosed in a box and allowed to work in an oil bath. This arrangement will reduce the friction coefficient between steel and bronze from 0·01 to 0·005. Gear constructed in this manner runs noiselessly, has only a slight wear, and a life of several years.

3. In order to reduce to a minimum the friction of the whole mechanism on the starting of motors at full load, the pressure is taken up by starting discs arranged on both ends of the worm.

The author, in conclusion, referred to illustrations of various combinations of this type of worm gearing with electric motors, as carried out by the Oerlikon Engineering Works with considerable success.

BUSINESS NOTICES, &c.

Annual Outing.—On Saturday last the employees of the Brighton Corporation Electricity Works journeyed to Arundel by rail. Various athletic sports were held.

Compressed Air and the Clayton Air Compressors.—The above is the title of the catalogue of the Clayton Air Compressor Works of New York, which contains not simply a description of the company's manufactures, but a series of illustrated descriptions of the many uses to which compressed air has been applied, as well as useful information on the transference of air in pipes, and of the loss of efficiency consequent on altitude. It is unfortunately not of the standard catalogue size, which we think a mistake. Large catalogues are very apt to be thrown aside because they are productive of an untidy bookshelf. Is it not probable that another use for compressed air might have been suggested, namely, the cooling of dynamo armatures and transformers by air which has been allowed to cool after compression, and will therefore be exceedingly cold when set free to expand over the dynamo?

Crompton & Co.—Messrs. Crompton & Co. are removing their electrical heating department from 148, Brompton Road to Cornwall Buildings, 35, Queen Victoria Street, E C. This step is necessitated by the increase of business, and the desirability of being in a more accessible position for enquirers who come from all parts of the country and abroad to see these new applications of electricity. The Brompton Road showrooms have answered the purpose of introducing electrically heated apparatus to the public, and showing the possibility of its use, and after three years' experience the department has now been placed on a permanent footing. All enquiries should now be sent to the new address, where Mr. H. J. Dowsing will be pleased to afford any information as to the various applications of electrical heating. The showrooms at Brompton Road will be kept open by the Kensington and Knightsbridge Electric Lighting Company for the benefit of their customers who may wish to see various applications of electricity.

"Niagara" Crusher and Pulveriser.—We are informed that Messrs. Easton, Anderson, and Goolden, Limited, have secured the sole rights for the manufacture of this machine (W. H. Coward's patent) which is claimed to be a very successful dry crusher for all classes of materials including phosphate rock, clinker, silver and other ores, flints, &c. We have received an illustrated price list giving a detailed description of the crusher, also prices thereof. The machine can be seen working at the company's shops at Westminster and Erith.

Paris Lighting.—Regarding our recent note on "Electrical Installation on the Paris Boulevards," Messrs. Shippey Bros., Limited, write us, raising a point respecting what was termed "A New Mode of Illumination." Our correspondents say that M. Champion's design is simply a modification of a system, the fundamental claims to which was patented by their Mr. Shippey in 1883. In the past 10 years they have supplied many of these electric revolving wheels, and during the Jubilee illuminations they were much used by many electrical firms. "All that M. Champion seems to have done is to have enlarged the size of the 'Shippey wheel,' from 1 to 2 feet as made by us, to 4 or 5 metres in diameter. All other details, such as rings of variously coloured incandescent lamps, change of effects during rotation of the electric motor, &c., are all explained in Mr. Shippey's system, which has many times been very favourably commented upon by the British and American Press, and undoubtedly the credit is due to him and not to M. Champion as inventor of the system. Singular to say the fancy coloured lamps as used in this method of illumination for advertising purposes, were also invented by Mr. Shippey and patented by him in France in 1884, as and for the purposes named in your note."

Price Lists.—From Herr Severin Senator, of Berlin, we have received his price lists of electric light carbons, new current-saving incandescent lamps, house telegraphy, telephony, &c., electric light switches, lamp-holders, and general electrical accessories. The lists are in English.

One of Messrs. Connolly Brothers' price lists (April, 1895) of vulcanised India-rubber and other electric light wire and cable has been sent to us.

The Empire of India Exhibition.—We learn that Messrs. Spagnoletti & Crookes have recently installed fire alarms on the Single-wire Multiple Telephone Signal Company's (Saunders and Brown) system at the Empire of India Exhibition at Earl's Court. These consist of three posts and two wall boxes so arranged that anyone can give an alarm of fire by breaking the glass and pulling a handle which rings a bell at the fire station, and also one of any required degree of loudness at the call point to assist in the detection of persons giving a wilful false alarm.

ELECTRIC LIGHTING NOTES.

Alsager.—At the District Council meeting last week a discussion took place on the report and estimate lately prepared by Mr. Pears, electrical engineer. His estimate provided for electric light at 6d. per unit. The cost he put at £7,500, repayable in 30 years. The whole question is to be brought before the ratepayers, and a committee was appointed to arrange the matter.

Belfast.—Mr. V. A. H. M'Cowen, the city electrical engineer, was some weeks ago requested to draw up a specification for the electric lighting of Purdysburn House, and tenders be secured for the Resident Medical Superintendent at the Belfast Lunatic Asylum.

Brazil.—The Brazilian correspondent of the *Financial News* says that before the end of September Petropolis will be lighted with electricity, the work being in charge of the Banco constructor.

At Itapecerica, San Paulo, the local authorities are at present considering a proposal to light the public streets by electricity.

Bristol.—A meeting of the Old Market Street Ratepayers' Association was held at Bristol on 19th inst. "to protest against the standards erected by the Tramways Company in place of the elaborate electric light standard," and transact other business. The Council discussed the same question on 13th inst.

An Exhibition is to be held at the Drill Hall at the end of September. The buildings have already been wired for 11 arc lamps in the Hall, and 50 or 60 incandescent lamps in the corridors.

Brechin.—At the monthly meeting of the Town Council last week, a letter was read from the manager of the Caledonian Electric Light Supply Company, Limited, to the effect that, as they intended to apply for a provisional order to supply electric light to the Burgh of Brechin, they wished the Council, before coming to a decision, to hear the terms of the company. The Clerk was instructed to ask for the company's terms. A circular was also submitted from the Town and Village Electric Light and Powers Company, Limited, which the Provost explained was somewhat of the nature of an advertisement, and on his suggestion it was left on the table. Mr. Murray gave notice that at next meeting he would move that, as they did not consider that Brechin at the present time was ripe for electricity, they should not go into dealings with any company in the way of supplying them.

Broadstairs.—The District Council has received a letter from the Town and Village Electric Lighting Company with regard to the supply of electric light. The matter has been referred to the Lighting Committee.

Canterbury.—The Town Council has empowered the Electric Light Committee to take such steps as they think fit for the purpose of making use of their provisional order. The Committee is to report as to the most suitable system.

Clewer.—The Lighting Committee has considered tenders for lighting the parish. Mr. W. F. Fountain has offered to provide 44 lamps at £2 9s. each, making a total of £107 16s., to light the same at 2d. each per night to cover everything, for six months of the year. That would cost £60. The feeling of the ratepayers is to be taken.

Coventry.—It is expected that the electric lighting works will be completed in about three weeks, and the Mayor desires to open them on the same day as he does the new water works.

The City Council has decided to adopt the "Brighton" system of charging for current.

Dover.—The Snargate Street ratepayers held a public meeting the other day, and resolved to ask the Town Council "to adhere to its resolution for lighting Snargate Street by electricity, and to carry it out at once."

Exeter Electric Light Company.—The annual general meeting of this company was held on 16th inst., but reporters were not admitted. The *Western Mercury* says that the proceedings were expected to be lively.

Factory Lighting.—Messrs. Churchward & Son's serge factory at Harbertonford was on Friday evening lighted by electricity. The installation was carried out by Mr. A. F. Lord, electrical engineer, Totnes. The dynamo was manufactured by Messrs. Newton, of Taunton, and supplies 140 lamps.

Germany.—A contract has just been granted for the establishment of a central station in the town of Meissen. The Stettin Electric Lighting Company has just declared a dividend of 6 per cent. for the last financial year.

Hospital Lighting.—The *Charity Record*, in an article on "Our Hospitals, and the Advancement of the Electrical Industry," of which we have been favoured with an advance proof, says that electric lighting has been adopted in the doctor's new room erected at the Central London Throat and Ear Hospital in Gray's Inn Road, W.C.

Infirmary Lighting.—We hear that Messrs. Drake and Gorham have been entrusted with the electric lighting of the Lancaster Infirmary, in which there will be about 250 lights, and also the electrical cooking arrangements, medical switchboards, telephones, bells, and speaking tubes.

Ipswich.—When the lighting question was under consideration, the other day, a member proposed that the placing of the gas contract be deferred for a short time, on account of the investigations regarding electric lighting, which are at present being made by a Committee. The proposal had no seconder, and the Town Clerk pointed out that "nothing could probably be done with regard to electric lighting which would affect the public lighting of the town within the next three years," which was the length of the gas contract.

Italy.—Messrs. Siemens & Halske, of Berlin, are establishing plant at Castellamonte (Ivrea) for the utilisation of the water-power of the Chiusella torrent. The plant, when completed, will include three 750-H.P. turbines, constructed by Messrs. Riva, Monneret & Co., of Milan, and three alternators. The electrical energy generated will be transmitted to Brella, 37 kilometres distant, Strambino, Ivrea, St. Georgio, and Rivarolo Canavese, for lighting and power purposes. The plant has to be in operation by July 1st, 1896.

Lagos.—A London daily says that a mass meeting, attended by 10,000 persons, was held on Saturday evening in Tinubu Square, when a resolution was adopted protesting against the Electric Lighting Bill submitted by the Government.

London.—We are informed that the wiring of No. 45, Ennismore Gardens, for Mrs. Goldsmid, is in the hands of the Tayler Smith Electric Company.

Middlesborough.—The Town Council is to engage an electrical engineer, at a sum not exceeding £50, to report the lowest capital sum, with plans, that would work an electric light installation on an economical basis.

Newport.—The supply of current is now nearly available for lighting the Town Hall and clock, also for tradespeople who had been kept waiting. At last week's County Council meeting it was stated that there was a difficulty about the engines supplied to the electric lighting works by the Uskside Engineering Company, "the makers of the plant (Messrs. Fowler & Co., of Leeds) having declined to allow their alternators to be coupled on until the governors had considerably more control over the speed of the engines."

Oswestry.—The Council is to consider the following report of a committee:—"The Committee reported that it was stated, on behalf of the Oswestry Electric Lighting Company, Limited, that the cost of installation of electric light in the whole of the rooms in the Guildhall (except the science and art class) would not exceed £50, at which sum the company agreed to instal same, and that the company offered to construct installation in science and art class rooms free of charge. Recommended: That the offer of the Electric Lighting Company, as to installation, be accepted (subject to the approval of the Borough Surveyor as to the position and number of lights required), and that the buildings be lit with electric light when constructed, at an annual cost not to exceed the sum paid to the Oswestry Gas Company for lighting the Guildhall, &c., during the preceding year."

Stafford.—Mr. J. S. Highfield has been appointed electrician at the Electric Supply Works, at a salary of £120 a year, and Mr. Dawson Clothier appointed assistant electrician, at a salary of £80 a year.

Stanton.—At the last meeting of the Swadlincote Urban District Council, Mr. Belfitt said it was intended to have the electric light at Stanton in working order by the middle of October.

Sunderland.—We learn that the Highways Committee have reported that the amount expended upon the electric light to June 30th last was £20,961 1s. 5d., and that there was a further expenditure anticipated which would bring the total up to £22,987 11s. 5d. Roughly speaking, the loss on the year's working was £700.

Tranent.—The Co-operative Society have introduced the electric light into their premises in Bridge Street. There are 120 lights scattered throughout the different departments. Two arc lamps light the front of the buildings. Messrs. Higgs & Co., Glasgow, carried out the work.

Weybridge.—There was a meeting of ratepayers held on 7th inst., and the lighting question was discussed at great length.

Yarmouth.—The electric lighting report shows the total loss on the half-year as £164, or a net loss of £130 plus repayment of capital and interest. The electric light is to be used at the Fish Wharf during the ensuing season.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Dublin Tramways.—A deputation of ratepayers waited upon the Dublin Corporation the other day to urge upon it the advisability of granting the request of the Tramway Company to extend the electric tramway system from Annesley Bridge to North Earl Street and Nelson's Pillar. The Lord Mayor, in reply, stated that the Corporation would give the matter every consideration. They did not oppose the extension of electric traction, but must be the judges of what was a proper system.

Electric Locomotive Business in the States.—Our New York exchanges announce that the Baldwin Locomotive Works and the Westinghouse Electric Manufacturing Company have agreed to "work as one, yet both plants will be retained as they are at present, extensions being made as business warrants." The Baldwin Locomotive Works were founded in 1831, and give employment to about 5,000 men. The capital of the firm is placed at $5,000,000. The Westinghouse Company has a capital of $10,000,000. Mr. George Westinghouse says it is not in any sense a consolidation, but a union of interests for the more economical and improved manufacture of electric locomotives, the demand for which is felt more and more every day. Secretary Terry, of the Westinghouse Company, states that there is a constant inquiry for electric locomotives, and although it cannot be said that there is a market now, the market will be found as soon as the engines are ready. The recent successful operation of electric locomotives has convinced the members of both companies that a union of interests for working purposes will be advantageous, and the contracts had accordingly been signed.

Electric Traction in Italy.—Plans have just been completed and approved for two lines of electric tramway in Genoa—one from the Piazza Corvetto to the Piazza De Ferrari, the other from the Piazza Manin to S. Ugo.

Electric Travelling Cranes in Belgium.—At the Cockerill Works at Seraing, electric overhead travelling cranes have been adopted in the locomotive erecting shop. The shop is served by two 3-ton cranes, while there is also one capable of lifting 40 tons.

Electric Traction in Germany.—An electric tramway is to be constructed between Furth and Nuremburg. It is reported that Messrs. Schuckert & Co., of Nuremburg, are about to experiment with a new system of electric traction on the tramways in that town.

Kingswood Tramways.—We learn from a local paper that it is not expected that the electric tramway to Kingswood will be opened until the end of September. "So far as the tramway company are concerned everything is practically ready, but there has been a delay in the supply of fittings for the boilers."

North Staffordshire Railways and the Electric Propulsion of Canal Boats.—At the half-yearly meeting of this company, held in London recently, the chairman in addressing the shareholders said:—"We have recently introduced the electric light into our principal station at Stoke. . . . . We have been able to light up with the electric light a large goods yard and warehouse, and it is the very best light which we can use, both for convenience and for the safety of the men who are employed in that work at night. The light has been very successful, and we are assured by our electrician that the result will be that we shall not only get in our goods yard, and in our station, and throughout the offices of the company, a much better light, but also a light which is cheaper. With regard to the exact cost I would rather wait to put figures before you till we have had full experience, but so far as we have gone we believe that it will be not only better, but also cheaper. We have an installation of our own, and boilers and dynamos, and all the necessary plant. Turning now to the canal, there is one part of it which is rather peculiar, and that is a long tunnel, at Hardcastle, which is 2,000 yards long. It is a small tunnel, and there is an old-fashioned habit which has existed for more than a hundred years of passing the canal boats through that tunnel by a system of legging. We have often considered the matter, but we have not been able so far to adopt any plan which would do away with that system of legging, which is a laborious and undesirable work. We shall give the matter our attention, and we are now turning our thoughts towards some system of electricity. We cannot get through the tunnel by steam on account of the vapour and smoke, but if we can, when electricity becomes more developed, adopt some kind of electric barge, without too much expense, for the purpose of towing the boats through the tunnel, we shall certainly ask your permission to do so."

Opening of the Laxey-Snaefell Electric Railway.—The electric railway to the top of Snaefell, in the Isle of Man, was opened to the public on Wednesday. It is the first of the kind in the United Kingdom, which reaches an altitude of over 2,000 feet above the sea, and connected to the Douglas and Laxey line, virtually completes an electrical railway system of 12 miles from Douglas to the summit of the mountain. Though the weather was unfavourable, and a thick mist prevailed, many tourists availed themselves of the opening and ascended the mountain. The cars ran with remarkable smoothness, and gave perfect satisfaction.

TELEGRAPH AND TELEPHONE NOTES.

Indian Telegraphs.—We learn from an Indian contemporary that it has been decided to construct a direct telegraph line between Madras and Bezwada, and the work is to begin as soon as possible. The first section on the railway line between Royapuram and Ennori should be ready for traffic in September next.

Russian Telegraphic Communication.—The *Times* for Tuesday last says:—"There seems to be some rather serious defect in the Russian telegraphic system. The *Novoe Vremya*, an enterprising organ of the press of the capital, published on Saturday a telegram from Vladivostok reporting the downfall of the Korean reform ministry and the flight of the minister of home affairs. We print this morning a full and interesting account of the same incident sent to us from our correspondent at Tokio, in a letter dated July 7th. It would appear, therefore, that it takes almost as long for news to travel from Korea to St. Petersburg by telegraph as to travel from Tokio to London by mail. The Russian authorities will no doubt have the overland wires repaired at once, as the rate of telegraphic communication between Vladivostok and the capital shown to exist by the almost simultaneous appearance of these two reports of the same events is little short of a danger to the empire."

The *Daily News* of 19th inst. contained the following:—"Strange as it may appear, Odessa has never been in direct telegraphic communication with St. Petersburg, all messages being still transmitted viâ Warsaw. In this great commercial entrepot of over 350,000 inhabitants there is only one branch telegraph receiving-station besides the Central, and nearly all the chief business houses and shipping firms go to the cost of having their received telegrams telephoned from the central station to their offices, copies of the actual messages being delivered usually a couple of hours later by messenger, although the chief business quarter of the city lies within a three-quarter mile radius of the telegraph station."

The Pacific Cable.—A despatch from Honolulu, dated 14th inst., says: "The Bill for the construction of a cable between California and Honolulu was passed to-day. The annual subsidy wa fixed at $40,000 for 20 years. The construction of the cable now depends on the obtaining of a subsidy from the United States Government."

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—September 4th. The Local Authority is inviting tenders for vulcanised India-rubber cables. Further particulars will be found in our advertisement pages.

Cowes.—August 27th. Tenders are invited for laying down electric lighting plant of sufficient capacity to supply at the same time 2,200 8-C.P. lamps, also public lighting and the laying of mains to accommodate 3,000 lamps. Details can be obtained from Mr. N. F. Dennis, engineer to the Council, Cowes.

France.—Tenders are at present being invited for the supply of four kilometres of paper-insulated double-conductor telephone cable. Tenders to be addressed to the Direction Generale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Germany.—August 24th. Tenders are being invited by the municipal authorities of Strasbourg for the supply of an electric travelling crane.

Hammersmith.—September 4th. The Vestry wants complete schemes for public and private lighting and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Particulars may be obtained from Mr. H. Mair, surveyor to the Vestry, between 9 and 5 (Saturdays, 9 and 1) on payment of £10, which will be returned to persons sending in a *bona fide* tender.

Holland.—The Dutch Military Authorities are at present inviting tenders for the establishment of a small central station for the electric lighting of the De Ruyter Fort, at Willemstad. Tenders to be addressed to the Café Het Schippershuis, Willemstad, Holland.

Islington.—August 27th. Tenders are wanted for the wiring of the Vestry Hall and Municipal Offices, and for the supply of fittings.

Killarney.—August 30th. Tenders are wanted for wiring the Killarney District Lunatic Asylum; supply will be obtained from the high tension mains of the Killarney Electric Lighting Company.

Portsmouth.—August 27th. Tenders are wanted for wiring and lighting by electricity the police stations at Buckland, Southsea, Portsmouth and Portsea. Full particulars can be obtained from the Town Clerk at the Town Hall.

Queenstown.—September 16th. Tenders are invited for the public and private lighting of Queenstown by electricity according to the report and specification of Mr. Robert Hammond, M.I.E.E., Ormond House, London, for the Queenstown Town Commissioners. Tenders are also invited as follows: The contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—October 2nd. The municipal authorities of Braila, Roumania, are inviting tenders until October 2nd next for the concession for (*a*) lighting about 64 kilometres of public streets by both gas and electricity, and (*b*) 64 kilometres of public streets by electricity alone. They are also inviting tenders for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares of the town. Tenders to the Maire, Hotel de Ville, Braila.

Vienna.—November 14th. The Municipality of Vienna ask for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

Wakefield.—August 24th. The Corporation Electric Lighting Committee invites tenders for the supply and erection of boilers, engines, alternators, switchboards, cables, transformers, arc lamps, &c., &c., for the intended electric lighting installation. Tenderers should take notice that estimates must be in to-morrow.

CLOSED.

Brighton.—The tenders sent in for the supply and erection at the Electricity Works, North Road, of evaporative brass tube surface condensers electrically driven air pumps, exhaust and condenser piping, for the Corporation, were as follows:—

Wright's Patent Heater Condenser Company, Westminster (accepted)	£2,476
E. Larsen, 19, Eastcheap, London	2,900
J. Fraser & Son, Milwall Boiler Works, London, E. ...	3,460

Halifax.—The Borough Council has accepted the tender of Messrs. John Fowler & Co., Limited, for the supply of the apparatus necessary for the extension of the switchboard, for the sum of £125. It has also empowered the Electric Lighting Committee to spend £1,000 for the purpose of electrically lighting Skircoat district.

Walsall.—The Borough Offices are to be lighted with electricity, and the tender of Messrs. Fallows & Wheatcroft for supplying and fixing the necessary fittings for the sum of £62 10s. has been accepted.

NOTES.

Pneumatic Fire-Alarm Telegraph System.—This device, the invention of Mr. A. Goldstein, of America, is entirely pneumatic and mechanical within the building protected, and embodies a magneto-electric machine for the transmission of the telegraphic alarm to the fire department headquarters. The system consists, essentially, of three parts, viz., a thermostat, which acts under the influence of the heat of a fire near it; an annunciator, which receives the alarm from the detector or thermostat, and indicates it by visual room or floor signal and the ringing of a mechanical bell; and a transmitter, which is also actuated by the thermostat, and transmits the alarm by wire to a predetermined station; all these connected by closed pipes within the building. The thermostat consists of a cylinder in which is a washer of asbestos coated with paraffin, and beneath the washer a loose-fitting piston, which receives the pressure of a spiral steel spring (piano wire), which spring is held under compression by a rod, the lower end of which is retained by two halves of a disc, which are held together by a solder which melts at a temperature of 150°. When the thermostat is subjected to this temperature, the two halves of this disc part, releasing the rod and the spring, which, by its upward thrust on the piston and washer, with a quick impulse, drives the air in the cylinder through the pipe, producing a corresponding impulse upon a small bellows or diaphragm in the receiver. There may be many of these thermostats on the same floor pipe, and the pressure of an alarm is prevented from being expended in them by check valves, which yield to pressure from within, but resist it from without the cylinders. The washer, saturated with paraffin, and fitting tightly in the cylinder, is hermetically sealed to it by the paraffin being melted around its edges, and is absolutely air-tight in its upward motion, in which it is facilitated by the softening of the paraffin from the heat to which the cylinder is subjected externally. The pipes from each room or floor, respectively, carrying a sufficient number of thermostats, are grouped together where they reach the annunciator, and the latter is connected by one pipe to the transmitter. The annunciator contains a clockwork, adapted when released to ring a mechanical gong; a number of shutters, adapted when dropped to designate rooms or floors in the building; and a number of bellows connected to the respective pipes, adapted when actuated by an impulse of air from a detector to drop the proper shutter and release the clockwork, thus ringing the local alarm, and visually indicating the location of the fire. This local alarm runs for nearly 15 minutes, and is for the purpose of alarming the occupants, if present, and also for calling attention of the firemen, when they respond, to the annunciator, which indicates the particular location of the fire. For that purpose, it is located, preferably, just within the main entrance of the building. The transmitter consists, essentially, of a magneto-electric machine, impelled by a weight, which is released by an impulse of air from any thermostat in the building, and is electrically connected by wire with the central exchange of the local telephone company. A wheel geared to the armature of this machine is furnished with contact springs, by which the number of the machine is telegraphically indicated in the usual way.

Arc Lamps in Series on Alternating Circuits.—A correspondent recently inquired whether there are in England any electric light installations where arc lamps are run three in series on a 110-volt alternating current circuit, or six in series on a 220-volt ditto. From inquiries we have made, we learn that several firms, including Messrs. Johnson and Phillips, the General Electric Company, Limited, Crompton and Co., Limited, and the Brush Electrical Engineering Company have at various times supplied arc lamps to run three in series upon 100 or 110-volt circuits, but where they are to be seen in operation we are not informed. For three years there have been five "Mensing" (old type) lamps running in series on an alternating current circuit, 200 volts, 5 ampères, at Mr. Wm. Whiteley's well-known establishment. The "Mensing" new type will, according to recent tests, run three in series on a 100 or 110-volt and 5 to 6 ampères, or more, alternating circuit.

Squabbling about Electrocution.—Dr. Peter J. Gibbons, of Syracuse, was recently interviewed by a member of the States press, and in the course of conversation the physician made several statements regarding executions as at present carried out in New York. Dr. Gibbons is one of those who, although he has witnessed several electrocutions, protests that electrocution with the current at present applied does not kill. In his conversation with the pressman he has made some sweeping charges, and declares that certain facts regarding the electrocution of two negroes named Johnson and Taylor have been hushed up. Taylor, he asserts, was killed by deadly drugs, and in his case the second application of the current was to a corpse. He also complains that he had not fair play in pursuing his experiments with his artificial respiratory apparatus in the case of the man Johnson. According to Dr. Gibbons, those present at Johnson's electrocution agreed that certain facts should remain one of the secrets of the death chamber, but Dr. Gibbons has himself broken the promise by disclosing the so-called "secrets" to the press. His statements, however, are flatly contradicted by the Warden of Auburn Prison, which contradiction is corroborated by the prison physician and four other doctors who were present. The Warden says:—"Dr. Gibbons had no more to do with Johnson's electrocution than did any other physician present. He listened for heart beats the same as the other physicians after the current had been turned off, and could distinguish none. He made no statement to the contrary when the man was declared dead. He was present at the autopsy also, but at no time by his own or other method did he attempt resuscitation. I certainly could not have allowed it any way. Just before the electrocution of 'Dink' Wilson, Dr. Gibbons wrote to me requesting that he be allowed to try his apparatus after the electrocution. I had no right to allow him to do as he requested, but I did offer him an opportunity to bring his apparatus here and test it, and demonstrate its worth or otherwise by trying it on a calf, through whose body we would pass the current. He declined to do so. His statement that drugs killed Taylor is absolutely false. . . . . Gibbons was not present, and his knowledge of the affair is limited to hearsay." A Chicago exchange ventures to hint that the doctor has an axe of his own to grind in his "artificial respiration" apparatus. This makes an investigation of the matter very necessary.

An Old Telegraph Line.—The Western Union Telegraph Company, says the *Electrical Engineer*, is making arrangements to retake possession of the old abandoned telegraph line, extending through British Columbia, started 30 years ago to run to Europe *viâ* Behring Straits and Siberia. This line was constructed as part of a great world circuit to connect Europe with America. The success of the Atlantic cable spoiled this plan. Now it is proposed to rebuild the old line and put Alaska in telegraphic touch with the world. The plan was known to the last generation as the "Collins Overland Line to Europe." The Russian Government began the construction of the 7,000 miles of line from Moscow to the Pacific Coast; while loop lines into China and India were carefully laid out. In America the Western Union Telegraph Company raised and spent $3,000,000 on the enterprise. It is thought that the Russian Empire will endeavour to meet the renovated Western Union line at the Behring Straits. The "Russian Extension," as it was once called, will not offer very serious competition with the Atlantic cables, but for strategic purposes it should have a high value.

Distributed Capacity in Wire Coils.—An interesting article on this subject, by A. S. Kimball, is given in a recent number of the *Electrical World*. It is pointed out, as the result of experiments, that "distributed capacity" in coils of wire is a possibility which must be taken into account even in some of our ordinary electro-technical measurements. With reference to this, we may remark that a few years ago Lord Rayleigh pointed out in a paper read before the British Association the importance of the capacity element in the use of resistance coils for telephonic experiments; double winding, it was shown, was not sufficient to eliminate inductive elements; it eliminated mutual induction, but capacity remained, and if not allowed for would be very misleading.

Independent Excitation for Turbine Driven Generators.—Writing to a New York exchange regarding "the steady voltage for turbine driven railway generators," Mr. F. B. Badt says:—

The method is very good, but it seems to me that you would have hesitated in calling it "The Ahearn Method" if you should have happened to remember the following paragraph from my paper, "Practical Notes on the Electrolytic Refining of Copper," read before the American Institute of Electrical Engineers, June 6th, 1892:—"A few words as to electric generators may not be out of place. The author prefers separately excited machines, for the reason that they cannot be reversed and other incidental advantages. When water power is used as a prime mover, a good deal of trouble has been experienced in the regulation of the wheels. As a matter of fact, there is no water governor in existence which will regulate so perfectly as the governor of a modern automatic engine under varying loads. By running all the exciters from an independent prime mover (either water or steam) the strength of the fields of the generators will be uniform at all times, whether there are fluctations in the external circuit or not; the strength of the field of the generators which, with self-exciting machines, is subject to the fluctuations in the external circuit, and is a variable, becomes a constant. The author proposed this arrangement over three years ago for railway and power stations with the very best results." It will readily be seen that what you please to term "The Ahearn Method" was suggested and tried by me as early as 1889. At the time I first suggested this method, I discussed with my patent attorney the question, whether it was a patentable invention or not, and he stated most positively that it was not. I simply mention this as a matter of record.

The Electrotherm.—One of the most utilitarian heating devices which have, so far, been constructed, is manufactured by the H. W. Johns Manufacturing Company, 87, Maiden Lane, New York, and known as the "Electrotherm." The device, which is described in the *Electrical World* (N.Y.), consists of a flexible sheet of asbestos, in which are embedded high resistance wires, forming an exceedingly convenient heating pad possessing many and salient advantages for use in hospitals, or even sick rooms in private families. The immense superiority, in point of convenience, of the electrotherm, as compared with the hot water bag or bottle heretofore universally used for local application of heat, is so obvious as to require only the statement that the one is designed to substitute the other. Superior convenience, however, is not by any means the most important of the advantages embodied in the arrangement, the vital points being the lack of danger from either over-heating or chilling the patient, and the possibility of maintaining a given temperature for days at a time without disturbing or uncovering the patient in order to renew the application, as is necessarily the case when any other form of heat application is used. The electrotherm, as generally furnished, is 11 × 15 inches in size, ¼-inch thick, and provided with a socket plug, connecting cord, and regulating switch.

South Staffordshire Tramways.—We extract the following from the report of the above company:—

Large additions to the expenditure were caused by the policy of the late board in consenting to the appointment of receivers and managers in May, 1893. No interest was in arrear at the time of the appointment, nor was there any real necessity for such proceedings, which it is believed were instigated for the express purpose of preventing the control of the company's affairs passing into the hands of shareholders hostile to the previous administration. . . . . Immediately on taking office the (new) directors resolved to commence an action for damages against Mr. Joseph Ebbsmith and Mr. Wain, the late chairman, in which £15,000 damages and other relief is claimed, and this action is being pressed to trial as rapidly as its important character will allow. Other proceedings have also been taken with a view to the recovery of money which the directors contend should never have been paid.

The receipts per car mile show a slight decrease for the year 1894, owing to the increased car mileage run on the electric sections.

Fuel Economiser Tests.—About nine months ago we announced some tests which were to be made at Bankside central station on Messrs. Green's ordinary economiser and Calvert's circulation economiser, Prof. Kennedy's services being retained for the purpose. We believe we are right in saying that for some reason or other these trials have not yet taken place.

Electrical Communication with Lightships.—A correspondent has drawn our attention to a slight error which occurred in our leader on this subject last week. We mentioned Prof. Lucien I. Bell's experiments at Sandy Hook. Instead of Bell, read *Blake*.

The Smillie Patent High-Pressure Pipe.—This comparatively new idea has taken the form of a company with the fairly moderate capital of £75,000, to manufacture. As most of our readers know, the Smillie pipe is simply a thin copper tube, covered from end to end by a wrapping of rectangular steel wire, laid close, and wrapped in a bath of molten alloy. The full strength of the wrapping is thus secured, as well as perfect safety against unwinding of the coil, which is secured throughout by the solder of the bath. We see no reason to doubt the success of the pipe, as such, though we may, perhaps, express surprise at the very limited use by engineers of spirally, or even lap-welded iron and steel pipe, which is now at such very low prices. We should, however, like to emphasise a possible danger, and that is the tendency that may arise in the future to cut down the thickness of the copper lining to unsafe limits—not unsafe in respect to the transverse pressures, which, of course, are borne by the wire coils, but in respect of the longitudinal tensions, which are considerable in large pipes, and are quite unprovided for in any system of coils. There is the same danger of rupture from insufficiency of this copper liner, as there would be in a Longridge wire gun from a too slight steel liner that alone takes up the longitudinal stresses in the gun, due to recoil action and frictional drag of the shot; this latter, obviously, sufficient in a thin liner to carry away the muzzle. With due regard to this point, we see no reason to doubt the mechanical sufficiency—and, indeed, excellence—of the wire-wound pipe.

Electricity at Sea.—Some interesting experiments have been made on the visibility of the electric light at sea by the Government of the United States, Germany, and the Netherlands. The result of the experience of the German committee was, that a white light of 1 candle-power was visible 1·4 mile on a dark, clear night, and one mile on a rainy night. The American tests resulted as follows:—In very clear weather a light of 1 candle-power was plainly visible at one nautical mile; one of 3 candle-power at two miles; one of 10 candle-power was seen by the aid of a binocular at four miles; one of 29 candle-power faintly at five miles, and one of 33 candle-power plainly at five miles. On an exceptionally clear night a white light of 3·2 candle-power was readily distinguished at three miles; one of 5·6 candle-power at four miles, and one of 17·2 candle-power at five miles. In the Dutch departments the results were almost similar, but a 16 candle-power light was plainly visible at five miles. For a green light the power required was two for one mile, 15 for two miles, 51 for three miles, and 106 for four miles. The result of tests with red light were almost identical with those with green, but it was conclusively proved that a white light was by far the most easily seen.

The Storm of August 10th.—It is perhaps worth notice that the severe thunderstorm of August 10th took place on the day of the maximum intensity of the annual meteoric shower which occurred August 5th to 12th. On the clear night of the 11th large numbers of meteors were seen, and possibly there were many during the daylight hours of the 10th, and they may have been the cause of the electrical disturbance in the evening of that day.

Crystal Palace O.S. Society.—The hon. secretary (Mr. J. C. Lyell) has sent us a copy of the rules and general particulars regarding this society, which we understand is composed exclusively of past students of the Crystal Palace Engineering School, the objects being the promotion of social intercourse and mutual assistance among the old students, and to further the general interests of the school. Any old students desirous of joining should communicate with the secretary at 55, Victoria Street, S.W.

Personal.—Mr. Charles H. Yeaman has been appointed assistant engineer, out of 52 applicants, on the electric lighting works of the Vestry of St. Mary, Islington, London, N. This is the first technical staff appointment made under Mr. Albert Gay, the vestry's chief electrical engineer, and it relates to the work of distribution more particularly.

Lecturer Wanted.—A lecturer is wanted for the Croydon County Polytechnic to lecture in electrical engineering and telegraphy and telephony.

Inverted Arc Lamps in Cotton Mills.—For the lighting of cotton mills, it is essential that as little shadow as possible shall be cast, and the inverted arc lighting system possesses the supreme advantage in this direction. In an article in the Electrical Review for November 23rd, 1894, we dealt with the progress which the inverted arc system has made in this country. The *Western Electrician* now cites an instance, showing the successful use of the method for some time past in a mill at Pawtucket, R.I. In the mill in question there were 42 inverted arcs in use during last winter, and next winter the entire works will be so equipped. The cost of installing 100 incandescent lights, or their equivalent illumination in arc lamps, has been found to be about the same with the present low price for arc lamps. The cost of maintaining the arc lamps at the present price of carbons, and including interest, is about the same as renewals on the incandescent plant. In favour of the arc lamps, you must remember that they are always up to full candle-power, while the incandescent lights begin to deteriorate from the moment they are put into service, and as they are generally allowed to burn too long, the result is that the illumination becomes very unsatisfactory. "We have been using incandescent lights, 20 C.P., for nearly 15 years, and so far as cost and illumination go, we prefer gas. We have long wanted to use the arc lamp, but its intense light and deep shadow has seemed to forbid its use in posted rooms, or rooms having much shafting and belting. Now that we can light by reflection, so that there are absolutely no shadows, the arc being invisible, while a soft mellow light reflected from a white ceiling is evenly diffused, we think we have found the ideal system for mill lighting. In the form in which we are at present using the light, there is some criticism from insurance men about the danger from sparks; but we think changes can be made to cover that point, and with this modification, we believe it is the best light yet invented for mill and store purpose." In regard to the important question of cost, the following comparative tests made in the month of January last will be interesting:—The braiding room, in which the first test was made, is 136 feet long, 66 feet wide, and 12 feet high. There are two rows of posts, a main shaft running about half the length of the room, and three short countershafts about the centre of the room. The machinery consists of 420 braiding machines, distributed in 14 rows of 30 machines each. The room was formerly lighted by 84 gas-jets. It is now better lighted by eight inverted arc lamps, placed in two rows, each row 17 feet from the side walls. The lamps are run two in series on the continuous current system, 110 volts, each pair of lamps taking 9 ampères of current. The test (2½ hours each evening) resulted as follows:—

The first evening 84 gas jets consumed 1,890 feet, at $1.50 per M	$2.83
The next evening eight arcs consumed 9,900 watts, at 15 cents per M	1.48
Difference	$1.35

or a saving of 47 per cent. A similar test was made in the worsted spinning room, the result being:—

The first evening 82 gas jets consumed 1,845 feet, at $1.50 per M	$2.79
The next evening 10 arcs consumed 12,373 watts, at 15 cents per M	1.86
Difference	$0 93

or a saving of 33⅓ per cent.

Electric Launches in the States.—Our trans-Atlantic namesake says that the Electric Transportation Company, of New York, has secured the electric launch concession for the Cotton States and International Exposition, which opens at Atalanta, Ga., on 18th ult. The service will comprise eight launches, 35 feet long, of exactly the same type as those used at the World's Fair. Each will be covered with an awning, and capable of a speed of 12 miles an hour. The course over which these launches will run will be over seven-eighths of a mile long. There will be five landing and two charging stations on the lake shore. A trial trip with one of the launches was recently made.

Out of Harness.—We cull the following from last night's *Pall Mall Gazette*:—

"Weed as one may, they will keep springing up, even when the very roots appear to have been dragged out.

> PARTNERSHIP or SYNDICATE.—£3,000 (not less) WANTED, as working capital to develop some 20 electro-medical patents owned by Mr. Harness and to re-establish the business lately carried on by the Medical Battery Company, of which for many years he was managing director. During that time the company earned large dividends. Apply direct to Mr. C. B. Harness, 52, Oxford Street, W.

It might savour of persecution to be too hard on this advertisement, but investors must be protected. Let it, then, be merely pointed out, firstly, that the £3,000 is to re-establish the discredited business for which a capital of £100,000 was found insufficient during its putrid career; secondly, that it is a puzzle how Harness can be in possession of twenty patents, if they were those of the Medical Battery Company, of which the last we heard was that its corsets were being offered at some North London draper's sale; thirdly, that no value was attached to the patents of the Medical Battery Company in the Official Receiver's statement; and fourthly, that as to the large dividends, the company failed to return half its shareholders' capital, and in the last year of its existence earned no profit at all. But it is scarcely to be feared that the Harness business will be commenced all over again, impudence notwithstanding."

Electro-Therapeutics.—Dr. Wm. J. Morton, of New York, some of whose works have been noticed in the Electrical Review, has sent us a few copies of his pamphlet on "Electricity in Medicine from a Modern Standpoint," reprinted from the New York *Medical Journal*, and "Electric Medicamental Diffusion," reprinted from the *Journal* of the American Medical Association, for free distribution. Any of our readers to whom these pamphlets will be of use can have a copy of either upon application to us at this office.

CITY NOTES.

Edison & Swan United Electric Light Company, Limited.

Mr. J. S. Forbes presided, last Friday, at an extraordinary general meeting of this company, and moved the confirmation of resolutions passed at an ordinary meeting held on July 29th, to the effect that the articles of association be altered so that the amount from time to time declared by the board as available for dividend be applied in such a way that there should be first set aside a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited on the "A" shares, and that out of the sum so set aside there should be paid a preferential cumulative dividend at the rate of 5 per cent. per annum paid on the amounts paid, or credited as paid, on the "A" shares without distinction. The motion was unanimously adopted.

The Brush Electrical Engineering Company, Limited.

The debenture stock transfer books of the Brush Electrical Engineering Company, Limited, will be closed from August 21st to September 3rd, both inclusive.

Albert Electric Lighting Company, Limited. — At meetings held on July 30th and August 14th, it was resolved to wind this company up voluntarily, and appoint Mr. G. B. Gates, of 12, Jerningham Road, New Cross, liquidator.

TRAFFIC RECEIPTS

The City and South London Railway Company. The receipts for the week ending August 18th, 1895, amounted to £934; week ending August 19th, 1894, £861; increase, £63; total receipts for half-year, 1895, £6,008; corresponding period, 1894, £6,063; decrease, £55.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending August 18th, 1895, amounted to £1,374; corresponding week last year, £1,126; increase, £248.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,753.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, August 14th.	Closing Quotation August 21st.	Business done during week ended August 21st, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	47 — 49	...	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88 — 89	88 — 89	89	88
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8½ — 9	8½ — 9	8½	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% § §	6½% § §	...	13¾ — 14¼	13¾ — 14¼	14⅛	14
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ § §	... § §	2½%	3 — 4	3 — 3½xd	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % § §	2 % § §	1½%	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14 xd	13⅛	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21 xd	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾ — 10¼	9¾ — 10¼	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 xd	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	3½% § §	2⅝% § §	2 %	9 — 9½	9 — 9½xd	9⅝	9 1/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% § §	6½% § §	6½%	17 — 17½	17 — 17½	17½	17
70,000	Do. 6 % Cum. Pref.	10	6 % § §	6 % § §	6 %	17¾ — 18¼	17¾ — 18¼	18¼	17⅞
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —129	127 —130	127¾	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅜ — 17⅝	17½ — 17⅝	17 1/16	17 7/16
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106 xd	102 —106	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106 xd	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —128	126 —129 xd	128½	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106 xd	102 —106	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108	105 —108	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛% § §	4⅛% § §	4⅛%	10⅛ — 10⅜xd	10⅛ — 10½	10⅜	10⅛
180,042	Do. do. 6 % Pref.	10	6 % § §	6 % § §	6 %	16⅞ — 17⅛xd	17⅛ — 17⅜	16⅞	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% § §	8⅜% § §	8⅜%	21¾ — 22¼xd	21¾ — 22¼	...	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	6 %	107 —111	107 —111	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000 ...	5	*nil*	4 %	...	1½ — 2½	1½ — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅝ — 6¼xd	5⅝ — 6¼xd	6⅛	5 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18 xd	16 — 18 xd	16½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16 xd	15 — 16 xd	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6¼xd	6 — 6¼xd	6 3/16	6
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107 xd	106 —108	107	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16 — 11/16	9/16 — 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½ — 4½	3½ — 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	126 —131	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½ — 3	2½ — 3	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97 xd	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½ — 6¼xd	5½ — 6¼	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	105 —108	105⅜	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½ — 2½	1½ — 2½	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	101¼	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10¼ — 10⅜	10¼ — 10⅜	10⅜	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¼ — 7	6¼ — 7	..	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4¼ — 4⅜	4¼ — 4⅜	4⅜	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	101 —105	101 —105	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¾%	¼%	⅜ — 1	⅜ — 1	⅜	⅜
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10¼	10 — 10¼	10⅜	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8¼ — 9¼	8¼ — 9¼	9 3/16	9 1/16
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5¼ — 5⅜xd	5¼ — 5⅜	5 1/16	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	6⅝ — 7¼	...	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	115—117	...	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14½ — 15½	14½ — 15	15¼	14 15/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½ — 16⅛	15½ — 16½	16½	16 1/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	9 — 10	8½ — 9½	...	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6½ — 7	6 — 6⅛	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅞ — 8⅛	7⅞ — 8⅛	8 1/16	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	11 — 11½	10¾ — 11½	11⅝	11 3/16
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	116 —119	116 —119	117	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 9	8½ — 9	8⅞	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8½xd	8 — 8½	8½	8¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 9½	9½	9⅛
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8¼ — 8¾	7¾ — 8¼	8⅝	8¼
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	8¼ — 8¾	7¾ — 8¼	8 5/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Aug 14th.	Closing Quotation, Aug. 21st.	Business done during week ended Aug. 21st, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §§	6 % §§	...	2 — 2¼	2 — 2¼	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §§	6 % §§	...	2 — 2¼	2 — 2¼	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000£	City and South London Railway	Stock	⅝%	⅝%	1¼%	41 — 43 xd	41 — 43 xd	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1 — 2	1 — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2½	2 — 2½xd	2½	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	104	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅜— 1	⅜— 1	⅞	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2½	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— 1	⅜— 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅞— 1½	⅞— 1½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10½— 11½xd	11 — 11½	11½	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 15½	15 — 15½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	..	...	...	104 —107	106 —109	108½	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	20	19⅜
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	10 1/16—10 1/16xd	10 1/16—10 1/16xd	10⅞	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½xd	15 — 15½xd	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44⅜	43½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜— 4⅝	4⅜— 4⅝	4⅝	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50°/ for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀§; 1891—7°/₀§; 1890—6°/₀§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.
Electric Construction Corporation, 6 % Debentures, 95—100.
House-to-House Company (£5 paid), 3¾—4¼.
Do. do. 7 % Preference, of £5, 8—8½.
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 8 1/16—8 3/16.
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¾—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ACTION OF THE ELECTRIC CURRENT ON ALUMINIUM WIRES.*

Amongst the singular properties that distinguish aluminium from other commoner metals, we may mention its very slight volatility at high temperatures. Although aluminium melts at a temperature intermediate between the points of fusion of zinc and silver, or at about 625°, this metal may be brought to a white heat without appreciably evaporating, and without undergoing any extensive oxidation. At this temperature most metals less fusible than aluminium become considerably oxidised, or partly evaporated.

If a fine aluminium wire is traversed by an electric current sufficiently intense to heat it beyond its point of fusion, we find, contrary to all expectations, that it may be heated to a dazzling white heat and remain in this condition; this is quite contrary to what happens with other metals subjected to the same test, which, when their point of fusion is reached, break suddenly, each broken end presenting the form of a little metallic globule produced by the contraction due to the superficial tension of the liquefied metal.

Aluminium acts very differently: if the wire is first stretched between the two supports that convey the current, it curves inwards considerably; but it can remain for some time in a state of complete incandescence until the moment when the breakage takes place, which generally occurs near the points of attachment of the wire. The aluminium wire evidently consists of a liquid thread, oscillating at the slightest breath, and held in the air by the cohesion of its molecules, and probably, also, by the formation of a very thin skin of aluminium which acts as an infusible protecting sheath round the metal in fusion. This skin is in every case very thin, for a microscopic examination does not reveal any very manifest traces of oxidation. The appearance of the metal is rather that of a bar roughly melted, in which a disengagement of dissolved gas has occurred, similar to what takes place with silver. The surface is rough, though bright, and covered with little, well-defined craters, many erosions, and here and there blackish stains, resembling graphite. Moreover, the wire has become brittle, as if the metal had undergone a kind of crystallisation. In the vacuum produced by an ordinary air pump, aluminium shows the same peculiarity of cohesion in a fluid state, but it seems to preserve more homogeneity than in the air. The same thing occurs if the experiment is made with carbonic anhydride.

The following table sums up some experiments performed in the air with aluminium filaments of different diameters and lengths. These figures are only approximate, for we could not deduce from them an exact proportionality between the intensity of the current and the resistibility of the wire at the temperature of white heat, this intensity varying between somewhat wide limits, according to the length of the wire introduced between the supports, which have a very considerable disturbing influence on the measurements. It is easy to see that the aluminium rapidly gives up to the supports part of the heat disengaged, and for wires of decreasing length we shall require increasing intensities of current to bring them to the same temperature. (See Table, page 243).

We see, for instance, that an aluminium wire, ·5 mm. in diameter and 10 centimetres long, can bear an extraordinary intensity of current (about 31 ampères) when it is at white heat. The resistibility of the wire increases in considerable proportions, since, for the same wire, the difference of potential at the extremities, almost *nil* at the commencement, as

* This article from *La Nature* is signed by M. Ch. Ed. Guillaume, but the first portion appears to be due to Prof. Margot.—Eds. Elec. Rev.

long as the current does not reach a sufficient point to heat the metal appreciably, increases rapidly till it attains the value of 5 volts, when the wire is heated to a dazzling white. The resistance of the aluminium wire, calculated for a square millimetre of section and a metre in length, would be about ·4 ohm, whereas when cold it is only ·03 ohm.

Length of wire.	Diameter.	Intensity.	Difference of potential.
m.	mm.	amp.	volts.
·033	·17	7	4
·033	·40	22	2
·033	·33	17	2
·1	·50	31	5

Results of Experiments.

This experiment, which is easily performed, consists in holding the extremities of the wire between two clamps, and

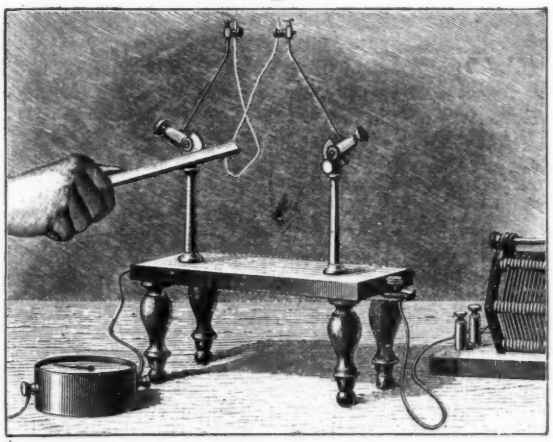


Fig. 1.—Action of a Magnet on a Current, demonstrated by the Aid of an Incandescent Aluminium Wire.

gradually increasing the intensity of the electric current up to the normal *régime* attained when the metal is quite luminous, *i.e.*, when it has the appearance of the filament of an incandescence lamp that is a little over-run; to put it too suddenly on short circuit, with all the intensity of current that the wire would be able to bear subsequently, would be likely to break it.

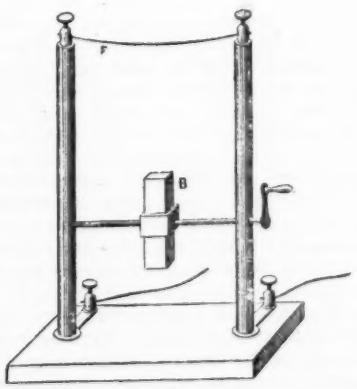


Fig. 2.—Other Variations of the same Experiment, the Pendulum Movement of the Wire Produced by the Rotation of a Magnet.

Moreover, the length of the aluminium wire may greatly exceed the above figures, although the fragility increases with the length of the wire. We have, however, succeeded in bringing to red heat wires 30 or 40 centimetres long, and, under these conditions, they have enabled us to give a definite, though transitory form to the influence exercised by a magnet on a circuit traversed by a current (fig. 1).

The wire, 25 to 30 centimetres in length and ·3 mm. in diameter, is fixed by its extremities to the supports that convey the current, so that at the bottom it can be formed into a loop almost closed and placed in a vertical plane. The loop being rendered incandescent by the passage of the current is extremely sensitive to the approach of a rectilinear magnet of average power, and according to the nature of the current or the pole of the magnet brought into its vicinity, is violently repelled or attracted. Generally, and here it is that the experiment becomes most instructive, the repulsion changes into a sudden twist of the loop, which naturally has a tendency to present to the pole of the magnet that surface in which the direction of the current is such that an attraction can be produced. The experiment is of short duration, for, at this moment, the sudden movement brings into contact the middle parts, and consequently short circuits the upper ends of the filament, which break off under the action of the intense current.*

Charles Margot,

Professor at the University of Geneva.

The very interesting experiment just described, which we have repeated more than once since M. Margot was kind enough to communicate it to us, certainly owes its realisation to the readiness with which aluminium becomes oxidised. Even at the ordinary temperature, in fact, this metal is covered with an adhering layer of aluminium, which protects it against other modifications, and explains several of its peculiarities. As this layer is pre-existant, an experiment *in vacuo*, or in a neutral gas, would only be conclusive if the metal was freed from it in the medium in which the experiment is prepared; for instance, by washing it with potash or a little diluted hydrochloric acid. The thickness of the layer is, moreover, slightly increased at high temperatures; in fact, we can still obtain a good electrical contact with an aluminium wire that has not been heated, whereas, after this operation, the contact becomes difficult and irregular. We know that it is the superficial oxidation that renders aluminium so difficult to solder; and all the methods of soldering this metal are based on scraping the surface and protecting it against the oxygen of the air. For turning operations, also, which are generally performed under some mineral spirit, protection against oxidation must be provided for, or the tools would soon be worn out.

It was this superficial oxidation that prevented Woehler from agglomerating the grains that he had first separated, so that he had to leave to Sainte-Claire Deville the actual invention of the first step in the metallurgy of aluminium.

We know, moreover, that a liquid cylinder, the length of which slightly exceeds three times the diameter, is unstable, and that the least bend very quickly becomes more pronounced under the action of the capillary forces, and in a very short time brings about the breakage of the cylinder. We may remember that on this very property a very curious instrument was based, Mr. Chichester Bell's hydraulic microphone, which we described a few years ago. From all this it follows that an aluminium wire, when heated to a temperature far above its point of fusion, only owes its stability to a kind of solid sheath, which completely encloses it, and prevents it from running together in drops; the low density of the metal moreover ensures the mechanical resistance of the chain that it forms between the two supports.

The first application that M. Margot attempted of the phenomenon that he had discovered is very interesting, and most effective for demonstration; it therefore deserves to be introduced into lectures on the subject, whenever a current of 30 ampères is available.

The lightness of the aluminium wire, and its liquid state, render it sensitive to the slightest influence; for instance, when preparing the experiment, we impart to the whole of

* These experiments succeed equally well, and with more certainty, with very fine platinum wires brought to incandescence, which, although less sensitive to magnetic influences, on account of their greater density, nevertheless show clearly, and under a very elegant form, the effects of attraction and repulsion due to the proximity of a magnet; it was, however, impossible for us to obtain clearly with platinum the curious turning round of the circuit so readily observed with aluminium.

the wire a very decided oscillating movement by the rotation of a rectilinear magnet placed at 50 centimetres, or 1 metre above or below it (fig. 2). With a horse-shoe magnet we can deflect it from its position, or twist it at will.

We can even go further than this: experiments with magnets are generally fairly easy, whereas the forces exercised by currents are more difficult to demonstrate. With an aluminium wire nothing is easier; if we convey the current by means of a vertical copper wire to an aluminium wire suspended from it, we can see the latter recoil sharply from its support as soon as it reaches a high temperature, whereas it falls back again as suddenly when the current is interrupted. The experiments that can be made with parallel wires are too evident for us to dwell upon them.

The brilliancy of the wire heated by a current renders all these experiments plainly visible to a large audience. This brilliancy which the wire assumes at a high temperature is no doubt heightened by phosphorescence of the alumina. This phosphorescence would even tend, from its very appearance, to make the temperature of the wire seem higher than it really was. Nevertheless, we must add that there can be no doubt as to its liquid state when it attains this dazzling whiteness.

THE COST OF WATER-POWER.

There is always a lurking doubt as to the real economy in water-power, owing to the liability of winter stoppages, and the outlay upon steam plant necessary to provide against such contingency in cold climates. Mr. Webber, in *Cassier's Magazine*, accepts the statement that a water-power is worth what it would cost to supply the same amount of steam-power at a given point, which seems a reasonable basis of comparison. The factors making up cost are the dam, wheels and accessories, and a fair allowance for depreciation, oil, attendance, &c., as against the cost of steam plant and fuel. Obviously, the height of fall and uniformity of flow must be of immense importance. Indeed, only a few days ago we saw a stream in flood, and measuring up its cross-section and velocity, we observed in about eight hours that it had lost about 20 times its normal horse-power, and still was flowing at several-fold its ordinary flow. Such a stream, shedding water quickly off a limited gathering ground, would, obviously, pay for damming to meet dry seasons. Evidently, having reference to Mr. C. E. Emery's figures, Mr. Webber states that many adverse opinions on water-power are based on the great capital expenditure at Lowell, where turbines of 23,000 horse-power have been placed on a fall not really suitable for more than 10,000 horse-power, and the cost of steam-power has been based on the production of a horse-power from 1¾ lb. of coal at about 12s. per ton, which brings out the annual cost at about 80s. to 88s. per horse-power. Now, one of the new mills in Fall River, having an engine of 1,050 H.P., used coal at the rate of 1·99 lb., and cost annually, with 10 per cent. depreciation, and coal at about 15s., 93s. per horse-power per year, while a 650 H.P. engine cost 105s.; and these figures are far less than the ordinary cost of steam-power in many water-power regions, and one author has gathered data showing that steam-power costs in many first-class places from £9 to £11 per year. Taking £10 as an average, and deducting a quarter for heating purposes, he finds £7 10s. to be a fair cost, to which adding depreciation brings it up again to £10 per horse-power year in New England, and taking different water-powers, it is shown that from 35s. to 45s. covers the annual cost for several cases, which agrees well with Mr. Webber's own ideal case of 42s., while Mr. Batchelder has stated that the average cost of water-power at Lowell, including land, was not over £3 per annum. He concludes that owners of water-powers need not hesitate to develop them, if coal costs over 8s. per ton delivered at the site; but in laying out their plans, they should be governed by the minimum flow of the stream, *plus* the amount that can be saved by night, and 80 per cent. net effect may be relied upon from a good turbine, corresponding to a horse-power for each cubic foot of water per second on a fall of 11 feet. Do not, however, as Mr. Webber has seen done, plant a 300 H.P. factory to use a stream that will only give 100 H.P. during six months of the year, and haul coal three or more miles to supply steam for the balance, as to which it might be pointed out that the mill need not be at the fall, but may be near the point of coal delivery, and the water-power may come along a wire from the fall. Finally, to gauge the value of the power, the figures suggested for coal consumption are 1½ lb. for triple expansion, or, say, 1¾ lb. to be safe; 2 to 2½ lbs. for compound, 2½ to 3 lbs. for single condensing, and 3 to 3½ lbs. for high pressure engines per H.P. hour. To the fuel cost add wages, oil, and 12½ per cent. of cost of plant as a sinking fund for renewal, &c., insurance, taxes, and the total will give the annual cost per horse-power on which to base the value of the water-power, which must be offered to users for less than this value, or users will be prone to use steam.

REVIEWS.

Dynamo Construction. A practical handbook, by John W. Urquhart. Second edition. London: Crosby Lockwood and Son. 1895.

As this book has reached a second edition, it has evidently found favour with the electrical masses, ordinary engineers, and mechanics for whom it is written. It is burdened with no theory to speak of, and is written in popular style throughout. We notice, however, that most of the errors of the first edition, both as regards illustrations and letterpress, are repeated. As we said when the work first appeared, the wording is loose and the treatment wholly unscientific, while the notions are frequently of the crudest character. There is no reason why the popular treatment of a subject should be inaccurate, and though to those for whom it is intended the book may do no harm, it is not too much to say that any student going seriously into electrical engineering would have to unlearn most of Mr. Urquhart's teaching before he could start fair. The chapter on the multiphase dynamo is brevity itself, only 10 pages, and perhaps this is something to be thankful for. Where the "ordinary engineer and mechanic" would have been, mentally, after Mr. Urquhart had tried to lead him through the mazy paths of diphase and triphase generators and motors, we hesitate to contemplate. As it is, saturated with the ideas in this book, we do not want to meet him.

Armature Windings of Electric Machines. By H. F. Parshall and H. M. Hobart. New York: D. Van Nostrand and Co., 1895.

This book, as its name implies, gives illustrations of all conceivable forms of armature windings. We doubt if electrical engineers on this side of the Atlantic will derive much benefit from perusal of the new work, as all the direct current armature windings in use in this country, or that need be used in any country, number something under a dozen. Of these the single ring winding is perhaps the best known, and is suitable for two or more poles. Cross connecting was at one time adopted in some machines having more than two poles, but it has been found much better and less costly to supply instead, for four poles, another couple of sets of brushes, and more than four poles are seldom used for the Gramme type of machine. The device of double or triple winding for large current armatures where the windings are independent circuits connected only at the brushes, is extremely useful, but, of course, this is only a modification of single winding and scarcely constitutes a type. Coming to ring armatures for high potential and small current, to run in multipolar fields, with coils connected in series, though some dynamos have been wound in this manner, it is very seldom adopted. Amongst the antiquities it will be remembered that the Andrew's and Perry dynamos had this kind of winding, in fact, if we remember rightly, the credit of having invented the series ring winding with the odd number of commutator sections belongs to Perry. Unfortunately, though Messrs. Parshall

and Hobart give several examples of series ring winding, they do not specify for what output of machines the several designs were employed, or if they have ever been employed at all, information which would have been extremely useful and would have enabled an engineer hesitating about the adoption of any particular form, to decide definitely as to its value for his special case. There are certain disadvantages in the series winding for rings which all designers know of, and a question worthy of the authors' consideration would have been at what size or output of machine having, say, four or six poles, should the parallel winding be abandoned and the series take its place. Having decided on such a winding the great thing, of course, is to get the whole perfectly symmetrical, and the connections between the coils as short as possible. The writers give many illustrations, and the diagrams, fanciful and otherwise, covering the ground we have just gone over, number no less than 24.

Dealing with drum armatures, we have the same wealth of illustration, but here, again, we have no clue as to whether the particular windings illustrated have, or have not, been successful in practice. Some we learn have been *discussed*, but this does not help us much. The chord windings we consider bad, and the authors correctly tell us that the chief objection to an odd number of commutator segments in a drum armature wound in the ordinary way is, that each coil in putting on has to be split over the shaft. It must be remembered, however, that for bar armatures this does not apply, nor even for wire wound armatures any longer, as in the best shops the winding is arranged symmetrically, and there is no crossing in the sense of the term applied to the old-fashioned methods. The two layer windings illustrated at pp. 62 and 65 would be now-a-days condemned, while windings with two layers having one set of coils wound above the other and top and bottom coils connected alternately to the commutator, are only useful for creating "flats" on the segments. Several diagrams for double and triple multipolar windings are given in Chapter VI. The number seems a trifle overdone, however, as with a knowledge of the principles involved we should have thought that the electrician could have varied his pitches all right to suit himself.

Coming to what we call in this country series-wound multipolar drums, we do not observe any statement regarding the principal advantage which this winding is said to offer. This is, that worked with two sets of brushes there can be no local currents in the armature if it gets decentred, an advantage which we are inclined to think more fanciful than real however. For high potential and small current no doubt this mode of winding possesses advantages, but for large currents it possesses very distinct disadvantages. Again, Messrs. Parshall and Hobart are content to leave us in a dilemma! At what point, for what output and size, are we to abandon the series winding in favour of the parallel? Figures 45 to 48 we do not pretend to consider seriously. Have they ever been used, if so by whom and for what? We consider double, triple, and quadruple two-circuit windings bad designing. The only cases in which these could be deemed at all applicable are met in a simpler way, so that there is no necessity to consider them. Some twenty-five of the diagrams are very pretty, and will be useful for professors to puzzle through in the long winter's evenings, or furnish nice patterns for the professors' wives to crochet toilet mats from, but, unfortunately, to the work-a-day engineer, they are of very little practical value.

The latter part of the work is taken up with alternating current armature windings, single, double and triple-phase, and here, as in other parts of the book, considerable information is given. Unfortunately, however, a great many of the examples do not apply to our practice here. The get-up of the book we may say is first-class, the printing is good both of letterpress and illustration. It is a misfortune perhaps that the men who would be referring frequently to a work of the kind are so few and far between; in any case we trust success will crown the efforts of the authors, and the only fault we have to find, if fault it is, is that they give us too much rather than too little for our consideration.

The Brush Arc Light System. By H. C. Reagan, Junr. New York: Norman W. Henley & Co., 1895.

We have read many descriptions of the Brush arc light apparatus, but the description given in this little book is far and away the best we have seen. There are plenty of illustrations showing everything in the fullest manner, and the descriptions are clear as regards every detail. The dynamo, regulator, wall controller, and mode of erection are each dealt with in turn, and in addition there is supplied with the book a cardboard chart of the machine with rotating armature showing the connections and the flow of current induced in the coils, through the armature into the commutator and external circuit as in actual practice. This chart, when not being used, is placed in a pocket inside the cover. Every student interested in the Brush system ought to have a copy of this little book.

Disinfection and Disinfectants. By Samuel Rideal, D.Sc. London: Charles Griffin & Co., Limited.

This is a treatise on a special branch of the wide subject now known as "Public Health." Dr. Rideal has taken up the question in three stages; first, what it is necessary to do; secondly, how precautionary or preventive measures are to be carried out, and what chemical or physical agents are available; and, thirdly, a general survey of the legal provisions affecting his subject. The principal, if not the only, electrical reference is to the Hermite or electrolytic process of treating sewage, and this abstracts the various reports of Drs. Piton, Kelly, Klein, Rüffer, the *Lancet*, and others. We have failed to find any reference to the Woolf process, which is similar to the Hermite, and has been developed in the United States. Ozone is dealt with fairly fully, but we think that Dr. Rideal might with advantage peruse the articles that have appeared in our columns on this subject from the pen of Mr. Andreoli. The references are very numerous, and as a piece of book-making we think that the writer has done his work well.

LONG-DISTANCE TRANSMISSION AT 10,000 VOLTS—THE POMONA PLANT.*

By GEORGE HERBERT WINSLOW.

(*Concluded from page* 215.)

These observations, which were made on the Pomona circuit during hot, dry and cloudless weather, show conclusively that the lines were heavily charged by the action of the wind. The wind, no doubt, blows electrified air and dust against the wires, the latter thereby accumulating a static charge with a rapidity which we have seen depended on the speed of the wind.

Some curious conditions met with in the operation of the plant are shown in the ampère curves in fig. 6, which were taken during very wet weather. Taking the maximum load measurements at 7 p.m. for March 14th and 8th, we note that the total apparent energy delivered by the sub-stations is 73 per cent. and 75 per cent., respectively, of that delivered by the generator, while for a smaller load at 9 p.m. the respective percentages decrease to 47·6 per cent. and 48·6 per cent., in spite of the fact that the apparent energy delivered by the generator is in the latter case only half as great as in the former. The results are due to changes in the angle of lag caused by changing the load.

In the canon curve of March 8th, the load at 9.30 p.m. is seen to have increased considerably, although the sub-station loads were decreasing. This increase was due to the fact that the rain, which had previously ceased to fall at Pomona, began again.

The electrical resistance of the Pomona circuit is 74·9 ohms, and that of San Bernardino 156·4 ohms at about 90 degrees Fahrenheit.

The insulation resistance of the circuits varies from far beyond the limits of an 11 megohm bridge in dry, hot summer weather to as low as 0·65 megohm during light rain. The latter value is that obtained with the two San Bernardino wires in series, and represents an insulation resistance per mile of over 37 megohms. On a clear, sunny day the insulation resistances of one Pomona wire and of one San Bernardino wire were, respectively, 11 megohms and 5½ megohms, which are in the exact relation which would be expected.

The lines cannot be tested for grounds or for continuity with a magneto bell, as their capacity is such that the bell will ring loudly when the wire is perfectly insulated and the circuit open. This capacity also prevents the use of the ordinary converter test for line leakage, as the lamp on the secondary will burn as though there were a ground even when the line is perfectly clear. By adding lamps, however, the light may be cut down until the last lamp added ex-

* Read before the American Institute of Electrical Engineers, Niagara Falls, N.Y., June 27th, 1895.

tinguishes them all. This would not occur if the light of the first lamp was due to a difference of potential on the primary caused by a ground, as then the added lamps would become as bright as the first. The primary current is thus seen to be limited and to be due to the capacity of the line. If the proper number of lamps has been added to just secure darkness when the line is known to be free from grounds the converter may be used to show grounds on that line, since the presence of a ground will cause all the lamps to brighten. The line test should only be made after ascertaining with one lamp that the generator is not grounded, as otherwise the leakage current for the greater number of lamps might burn the insulation of the generator. A very good example of Prof. Fleming's "condenser effect" was met with in the summer of 1893, while the engineer was trying this converter test for measuring line leakage. The primary of a thousand 100 volt converter was connected between the ground and one terminal of the generator, the other terminal of the latter being connected to one wire of the Pomona circuit. The resulting secondary pressure was 30 volts, which made one lamp burn dimly. When 10 lamps were turned on the pressure dropped to 14 volts. When all lamps were turned off the pressure became 10 times as great, or 140 volts. One generator brush was then raised and the second leg of the circuit was connected to the first. On completing the circuit again there was a sudden flash of the armature, followed by a crackling noise and a brush discharge which lasted until the circuit was broken. The Pomona wires were then disconnected from the dynamo terminal, which was left free. With this arrangement faint sparks and a glow were noticed, as though the armature winding were grounded on the core, but a Wheatstone bridge test showed an account of the single lamp being left burning. It is also possible that the breakdown in the other test was assisted by the presence of copper dust on the winding.

A comparison of the San Bernardino switchboard voltmeter was made with a Weston instrument and gave important results.

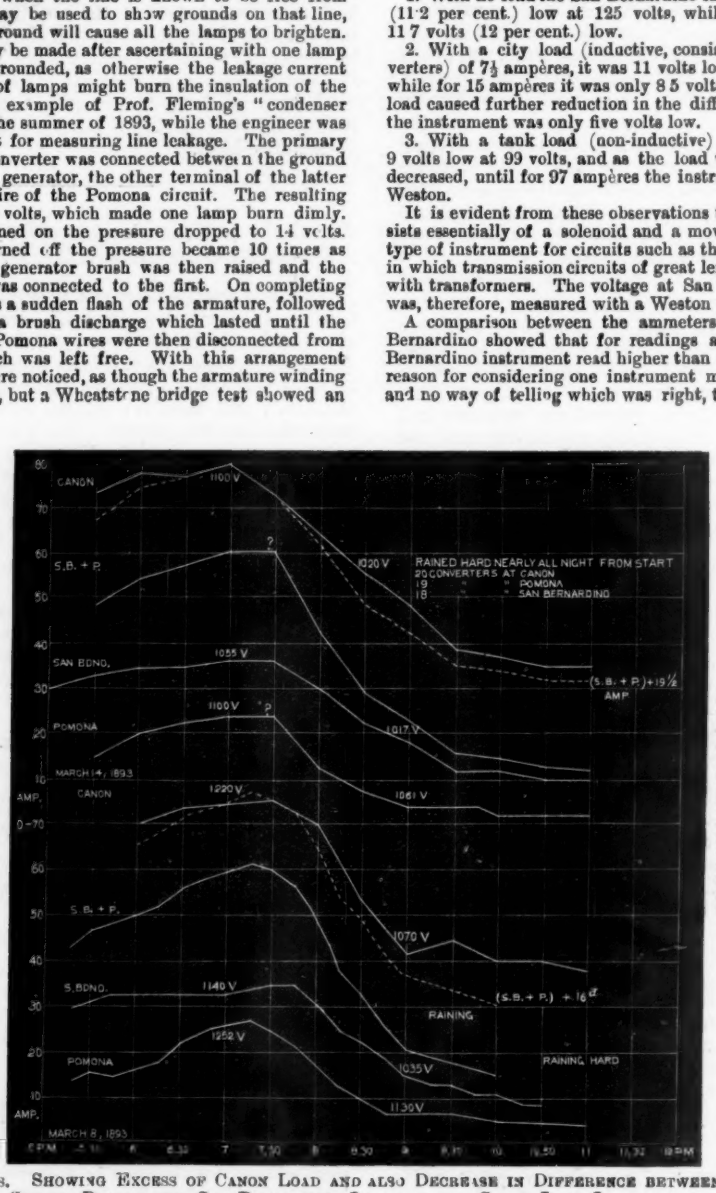
1. With no load the San Bernardino instrument was about 14 volts (11·2 per cent.) low at 125 volts, while at 97 volts it was only 11·7 volts (12 per cent.) low.

2. With a city load (inductive, consisting of lightly loaded converters) of 7½ ampères, it was 11 volts low between 107 and 96 volts, while for 15 ampères it was only 8·5 volts low. Further increase in load caused further reduction in the difference, until for 40 ampères the instrument was only five volts low.

3. With a tank load (non-inductive) of 9 ampères, it was only 9 volts low at 99 volts, and as the load was increased the difference decreased, until for 97 ampères the instrument read the same as the Weston.

It is evident from these observations that a voltmeter which consists essentially of a solenoid and a movable core is not the proper type of instrument for circuits such as those used in the present case, in which transmission circuits of great length are used in conjunction with transformers. The voltage at San Bernardino during the tests was, therefore, measured with a Weston portable voltmeter.

A comparison between the ammeters used at Pomona and San Bernardino showed that for readings above 67½ ampères the San Bernardino instrument read higher than the other. As there was no reason for considering one instrument more accurate than the other, and no way of telling which was right, the San Bernardino readings



Note increase due to rain. Raining in afternoon and nearly all night at Pomona. Snowing throughout canon and a mile or so outside of mouth of canon. Eight inches of snow at power house, covering insulators and cross-arms completely. One inch of snow on wires. Snow damp and clinging. No wind. 20 conductors at canon, 19 at Pomona and San Bernardino. 12 p.m.

FIG. 6.—AMPERE CURVES. SHOWING EXCESS OF CANON LOAD AND ALSO DECREASE IN DIFFERENCE BETWEEN CANON LOAD AND THE SUM OF POMONA AND SAN BERNARDINO LOADS AS THE CANON LOAD INCREASES.

insulation resistance of over 10 megohms. Since then the machine has been used regularly and has not broken down, so it is evident the spark must have resulted from a sudden increase of the potential of the armature winding above that of its core, which latter was permanently connected to earth.

This sudden increase may be explained as follows: On closing the circuit the condenser formed by the line and the earth began to discharge through the metallic circuit afforded by the armature and converter windings, but the inductance of this circuit checked the discharge so quickly as to produce an excessive pressure which could only be relieved by the discharge taking place through the insulation of the armature winding to the grounded core, which is what happened.

A similar test was made on the San Bernardino wires in the previous January during dry weather, the only change being that the single lamp was not turned off. With only one wire connected, one 16 candle-power lamp came nearly to candle-power. On connecting the second wire to the first (at San B.) the lamp burned at full candle-power. Ten lamps (the full load) were then put on the converter and burned dimly. As they were turned off one by one the others brightened, until the last lamp lighted up as before. This test did not cause any discharge on the armature, in spite of the fact that the circuit was twice as long and the capacity thus twice as great. The probable explanation of this is that the inductive resistance of the converter was not so great as in the other case, on taken during the test were reduced to the average of simultaneous readings on the two instruments.

A short test of the Pomona circuit was made on April 11th.

A preliminary efficiency test on the San Bernardino circuit was made on April 13th, 1893, with the results shown in curve in fig. 7. In this, as in all the other tests, a variable load was obtained by the use of a water resistance.

An efficiency test of the San Bernardino circuit lasting five hours, during which the generator was kept at full load or over-load, was made April 14th, 1893. Readings were taken every 15 minutes, and the efficiencies and the corresponding voltages for different loads are plotted in fig. 7. The most prominent feature of this efficiency curve is its irregularity. This is, however, satisfactorily explained by referring to the curve of generator voltage, on which it is seen that the high efficiencies correspond to high voltages and *vice versâ*.

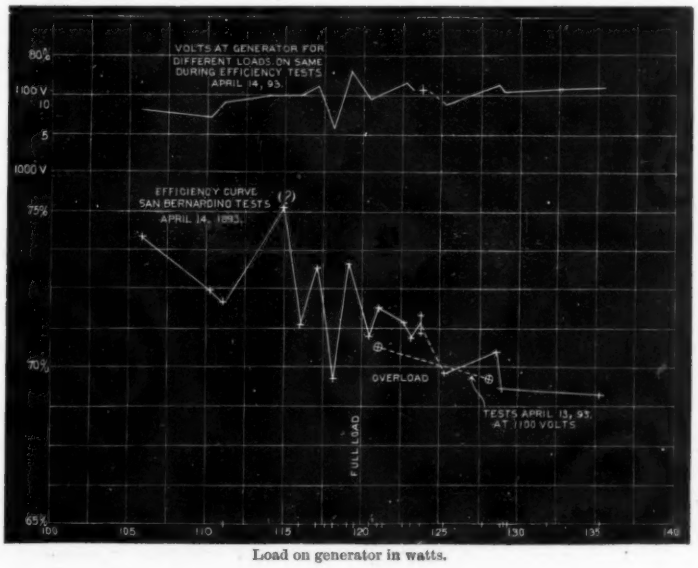
It will be noted that the apparent efficiencies shown by the preliminary test at San Bernardino agree very closely with the results of the long efficiency test there. On calculating the apparent efficiencies for different loads from data obtained by laboratory tests and comparing them with the measured apparent efficiencies, it is found that they agree within three or four per cent. This very close agreement is exceedingly gratifying, particularly when we consider that the tests of the plant were made with ordinary commercial instruments and that the laboratory tests were made about a year before the commercial tests.

An interesting and unique test was made May 2nd, 1893, by connecting the Pomona line wires in series with the San Bernardino circuit and transmitting about 100 horse-power to San Bernardino by way of Pomona. The length of the circuit was 85 miles and the distance of transmission 42½ miles. This is the greatest distance yet covered by any transmission since the Frankfort experiments.

The apparent efficiencies are much lower than those indicated by calculations, as in the latter no account was taken of the capacity and inductance of the circuit. The voltage of the generator, as measured, is about 5 per cent. above that calculated, and the ampères measured notably exceed the ampères calculated. These results are attributable to the introduction of the Pomona loop, which added both capacity and inductance.

In order to reduce the cost of operation, the San Antonio company first dispensed with the sub-station attendant at Pomona after 11 p.m. This they did sometime before the acceptance of the plant, after assuming the responsibility for any damage which might result. No trouble occurred, and, after the acceptance, May 6th, 1893, the same plan was put in operation at San Bernardino. After working in this way for several months the Pomona station was started in the afternoon and then locked up until the next morning. This arrangement was made possible by running the generator so that the lights should not be too high at Pomona, the lights at San Bernardino being kept right by the attendant with the Stillwell regulator.

In January, 1894, another 120 kilowatt generator was installed with an equal capacity of oil transformers, and the Pomona and San Bernardino circuits are now each operated from separate generators with separate banks of transformers of 10,000 volts. Since this change the San Bernardino attendant has also been dispensed with, and the bookkeeper starts up in the afternoon and then locks up the station for the night, as at Pomona. The voltage of the lamps on each circuit is regulated by the engineer at the power house, the generator pressure necessary at different loads to keep the lamps at



Load on generator in watts.

FIG. 7.

the proper brilliancy being automatically indicated by the compensating voltmeter on each circuit. Thus, after the plant is started, the engineer has sole charge.

NEW PATENTS—1895.

14,801. "Improvements in the electrolytic production of oxides and salts which are insoluble or practically insoluble in the electrolyte." C. LUCKOW. Dated August 6th. (*Complete.*)

14,804. "A combined electric bell press, pear press and holder." O. Y. RHODES. Dated August 6th.

14,840. "Spray electrolysis." F. W. DURHAM, jun. Dated August 6th.

14,842. "Improvements in electric condensers for use in polyphase and multiphase alternating current circuits." W. P. THOMPSON. (Communicated by C. S. Bradley, United States.) Dated August 6th. (*Complete.*)

14,847. "Improvements in electrically insulated pipes and in the method of joining the same together, and in insulating cement or enamel used in connection therewith." A. J. P. WHITAKER and F. G. TREHARNE. Dated August 6th.

14,858. "Improvements in electric meters." J. HARRIS. Dated August 6th. (*Complete.*)

14,902. "Improvements in plates for secondary batteries." G. FABBRO. Dated August 7th.

14,914. "Improvements in overhead conductors for electric railways and tramways." W. J. BREWER. Dated August 7th.

14,937. "Improvements in electric block-signals for railroads." A. C. GORDON. Dated August 7th. (*Complete.*)

14,973. "Improvements in prepayment apparatus for attachment to gas, electricity, or other fluid meters." W. WEBBER. [Date applied for under Patents, &c., Act, 1883, Sec. 103, April 16th, 1895, being date of application in United States.] Dated August 8th.

14,984. "Improvements in the manufacture of insulated cables." G. H. NISBETT. Dated August 8th.

15,024. "Electrolytic production of amalgams, and their utilisation." E. ANDREOLI and G. ANDREOLI. Dated August 9th. (*Complete.*)

15,057. "Improved means and apparatus for regulating or compensating for the variation of voltage in electric circuits." SIEMENS BROS. & CO., LIMITED, and H. S. S. HARVEY. Dated August 9th.

15,069. "Improvements in and relating to telephony." J. S. BIGGAR. Dated August 10th.

15,114. "Improvements in electric current meters." C. ERDEN and E. BERGMANN. Dated August 10th. (*Complete.*)

15,119. "Improvements in electrolysing-apparatus." L. A. G. E. R. COMBOUL. Dated August 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

4,021. "Improvements in telephone transmitters and arrangements for same." A. C. BROWN. Dated February 24th. Consists in clamping the diaphragm between a hard and rigid flatly ground or faced ring seating on the one side, and a resilient compressible or elastic spring ring on the other, the said spring ring being compressed by the clamping to a certain definite pressure (depending on the composition, thickness and diameter of the diaphragm used) and no more, and to secure that such clamping pressure shall thereafter remain absolutely invariable. 6 claims.

8,539. "Improved telephone exchange system." E. ANDREOLI. (Communicated from abroad by P. E. Raverot, of Paris, and G. A. Hess, of la Garenne.) Dated April 30th. Consists of a manner of distribution and association of the ordinary elements of multiple double cord switchboards, this mode of association being based upon the arithmetical principle of combination. 9 claims.

10,032. "Improvements in and connected with electrolysis, and in apparatus connected thereto." E. GAUTIER. Dated May 23rd. Consists in cooling the positive and negative electrodes in every case according to the chemical element or compound to be obtained, that is to say, so that the temperature of the electrode must never be allowed to approach such a temperature that the element or compound forms combinations other than intended or disappears altogether. 3 claims.

10,463. "Improvement in cells or boxes of electric batteries." J. M. Moffat. Dated May 30th. Consists of forming the sides of the the cell higher than the sealing on lid covering the plates, and curling inward the top edge all the way round so as to form a hollow lip above the cell lid or cover. 3 claims.

11,022. "Improvements in alternate current rectifiers, and apparatus connected therewith." S. Z. de Ferranti. Dated June 6th. Consists in rectifying a high tension current by coupling two or more commutators all on the same shaft and running by the same synchronous motor in series. 15 claims.

11,160. "Improvements in apparatus for starting electric motors." H. W. Ravenshaw and Messrs. Easton, Anderson & Goolden, Ltd. Dated June 8th. In the main circuit to the motor is placed in series a number of resistances, preferably divided in two groups, and connected to two distinct switchboards of usual construction. which control the throwing in or out of the said resistances in the said circuit. A switch of the usual construction for the reversal of the current to the motor may also be employed in addition, by which the rotation of the motor may be reversed at will by an attendant. 4 claims.

11,241. "An improved electric lamp." F. R. Boardman. Dated June 9th. The inventor combines some suitable substance of a refractory nature (such as lime or marble) with the ordinary carbon electrodes and placed between them so as to expose the said substance to the electric arc, but making provision for bringing the electrodes together for the purpose of striking the arc, and adjusting the distance between them as waste occurs in burning, by two racks placed parallel to each other, and respectively connected to each carbon holder. 4 claims.

11,452. "Improvements in connectors for conductors used with electrical apparatus." R. E. B. Crompton and H. J. Dowsing. Dated June 13th. In the ordinary form of connectors for conductors used with electrical apparatus, the parts consist of a plug or male portion, provided with one, two, or more projections, which fit into corresponding holes or recesses in the socket or female portion of the connector. The present improvements consist in protecting these holes by providing them with a movable shield or cover. 1 claim.

11,483. "Improvements in driving dynamos and other machinery by water-power." J. E. Liardet. Dated June 13th. Relates to the attachment of water motors in any convenient position to, or adjacent to, water mains, or to any subsidiary pipes, to be connected to such water mains, whether in the roads, paths, or in any buildings, so that such motors may be actuated by the pressure of the water passing through such mains or pipes without in the least deteriorating the pureness of the water for consumption. 6 claims.

11,559. "Improvements in magneto-electric motors." H. Ludeke, E. L. A. Ludeke, A. J. Thorman, E. de Bunsen, and E. M. Hore. Dated June 14th. Claims:—1. The arrangement of the series of permanent or other magnets in semi-circles eccentric with the shaft in a first battery or motor proper, or in such varied position whereby a rotation of the shaft is obtained by the revolving magnets or by attraction, repulsion, or movement of the same, aided and assisted by a second and third or more batteries all substantially as described and set forth. 2. The application of the assisting or auxiliary magnet as described and shown. 3. The combination of the several batteries and parts forming the improved magneto-electric motor described and shown in the drawings.

12,221. "Improvements connected with electrical furnaces." P. M. Justice. (A communication from abroad by E. G. Acheson.) Dated June 23rd. Has for its object to improve the construction and arrangement of the mechanical parts of said furnace, and also to improve the arrangement of the materials supplied to the furnace, for the purpose of utilising the electric current more economically, and producing more extensive and satisfactory results, and thereby to cheapen the product, as well as to improve the same. 8 claims.

12,304. "Improvements in and relating to electric telephone systems." H. N. Frenay-Olyff. Dated June 25th. Has for its object to simplify the arrangement at the central station and also at the stations of the subscribers. 6 claims.

12,476. "Improved system of switching and regulating apparatus for central stations for the generation and distribution of electrical energy." J. S. Raworth. Dated June 27th. The main feature of the improved system is simplicity which is primarily obtained by the parallel working of exciters and dynamos. 4 claims.

12,650. "Improvements in storage battery plates." B. M. Drake and J. M. Gorham. Dated June 29th. Claim:—A secondary battery plate, consisting of a number of strips or plates arranged with their edges to the front and back, and a clear space between each and the next, the said space being sufficient to allow of free electrolytic action.

12,816. "Improvements in or relating to marine engine telegraphs and similar devices." B. G. Hjarne. Dated July 2nd. Relates to an automatic answering telegraph from the engineer to the captain, which will at any moment show the captain of the position of the engine controlling gear, and it has also the purpose of serving, as it were, to prove at an eventual dispute, if mistakes in the manœuvring have been made. 8 claims.

12,817. "Improvements in electric incandescent lamps." A. Zobel and F. Buchmuller. Dated July 2nd. In incandescent lamps with replaceable filament, consists therein that one of the connecting wires belonging to one of the filaments is not, as heretofore, soldered on to the setting, but, like the connecting wire of the other or replacing filament, it projects out of the basis of the lamp so as to be capable of being connected to, and disconnected from, the contact plate, so that the similar connecting wire for the supplementary or replacing filament may more easily replace it. The contact plate is provided with a slot or hole to receive said wire. 1 claim.

12,867. "Improvements in telephone cabinets, and other structures, where it is desirable that they should be sound-proof." T. Weighill. Dated July 3rd. The structure is formed with double hollow or cellular walls, each wall being formed either by fastening two single hollow walls together, or by dividing each wall vertically into two separate hollows or cavities by means of suitable panels or boards. The hollows in the walls are filled with fibrous peat, slag wool, asbestos, sawdust, spent tan, or other suitable material. 2 claims.

12,982. "Improvements in electric arc lamps." J. Brockie. Dated July 4th. Relates to a simple and strong construction of the framework, and convenient arrangement of the working parts of electric arc lamps. 1 claim.

13,063. "Indicating lamp failures in electric lighting circuits and apparatus therefor." G. J. T. J. Parfitt. Dated July 5th. Consists in arranging in conjunction with the lighting main a pilot circuit which may be a metallic circuit or partly a metallic and partly an earth circuit. This pilot circuit is provided with a battery, a bell, and an ammeter. In connection with each of the lamps is arranged a closing device having an electro-magnet, the armature of which is in the pilot circuit and is normally in position to retain the pilot circuit open, but which in the case of a lamp failing serves to close the pilot circuit and ring the bell at the station so as to indicate to the attendant that a lamp has failed. The attendant can then by switching the bell out of circuit and the ammeter in circuit ascertain the position of the lamp that has failed, the resistance indicated by the ammeter being inverse to the distance of the defective lamp. 2 claims.

13,082. "A method of and apparatus for fixing or erecting telephonic, telegraphic, or other wires." C. Shore. Dated July 6th. The object of the invention is to provide an arrangement or apparatus for attaching or erecting telephone, telegraph, or other wires in position, but is more particularly adapted for erecting or fixing an additional wire or wires in connection with an existing series or line or lines of wire. 3 claims.

13,136. "Improvements in, or appertaining to, submarine telegraph and like cables." H. A. Taylor and J. A. L. Dearlove. Dated July 6th. Consists in taking advantage of self-induction set up in the cable, and by the introduction of a "leak" circuit. 4 claims.

13,267. "Improvements in galvanometers." J. Hopkinson. Dated July 9th. Claim:—A galvanometer consisting of a conductor carrying the current to be measured, and of an electro-magnet, or electro-magnets, movable in relation to the conductor, the electro-magnet, or electro-magnets, having a core or cores of small section, and expanding pole-pieces opposed to each other on opposite sides of the conductor carrying the current to be measured and excited by a current supplied by a source of electricity, the potential of which does not vary greatly.

15,617. "Improvements in apparatus for registering the number or duration of telephonic conversations." A. Munch. Dated August 16th. The apparatus records automatically and reliably the number or the duration of the conversations carried on, the operation of the registering mechanism being effected by electricity by means of single impulsions of the current which excite an electro-magnet which serves to move the registering mechanism. This electro-magnet is so connected with the switch mechanism of the central exchange that when the plug is used at the central exchange for the purpose of connecting or separating two subscribers' instruments, circuit-closing devices are automatically brought together or separated, for instance, by the action of the plug upon a plate, the circuit of the electro-magnet being by this means either closed or opened, so that it acts upon the registering mechanism. 5 claims.

15,816. "Improvements in or relating to automatic telegraph apparatus for indicating the direction and speed of motion of marine or other engines. P. Douglas. Dated August 20th. The inventor couples, by means of a connecting rod or chain, either the forward or backward eccentric rods with a rotatable sheave or pulley, mounted on the frame of the engine or carried by the condenser or any other convenient part. An endless chain connects this pulley to another pulley or wheel on a spindle which operates the tell-tale pointer on the dial of the transmitting instrument. 3 claims.

15,843. "An improved telegraphic apparatus for transmitting domestic orders or other signals." L. Boudet and P. Lacombe. Dated August 20th. The apparatus is composed of two electrically connected pieces of apparatus, namely a transmitter and a receiver. Each of these is provided with a dial or dials having spaces into which cards, or the like, may be placed, bearing any desired words, such as the names of articles likely to be required or ordered in the particular place where the apparatus is fitted. 4 claims.

18,359. "Improvements in or connected with electrical elevating mechanism." B. Willcox. (Communicated from abroad by the "Eisenwerk late Nagel & Kaemp, Actien Gesellschaft" of Uhlenhorst, Hamburg.) Dated September 27th. Consists in providing the reversing device with a very wide zero section for the contact brush lever, and in positively coupling the latter to a releasing brake, which may be of any suitable construction. 1 claim.

19,176. "Improvements in or connected with telephone indicators or annunciators." L. M. Ericsson. Dated October 9th. Relates to telephone indicators or annunciators having two magnet coils, one for causing the flap to drop and one for raising it. 5 claims.